Hip & Knee Preservation
an OSSAP Monograph
Volume IV, 2023

This book is dedicated to

Dr. I. V. Renuka,

S. Amritha Priyanka & Dr. Harsha Surath

and my Teacher

Dr. G. Narasimha Reddy

- Dr. Amarnath Surath

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President's Message

I congratulate the monograph team for choosing a topic of great relevance to the present scenario. The wheel has turned full circle and the accent is now on preservation of joints. A natural joint has a greater advantage to the patient espcially in our rural population. This said, there is a definite role for arthroplasty in properly indicated cases. The practice of rational orthopaedics requires a healty balance between preservation and arthroplasty keeping in mind the well being of the patient.

Dr. V. Dharma Rao
President, OSSAP

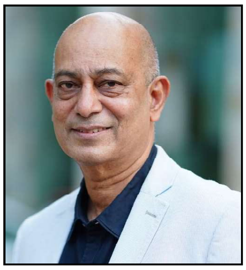
Greetings from the office of secretary of OSSAP

It gives me immense pleasure to present before you "The OSSAP Monograph" series. The monograph on "Hip & Knee Preservation", is first of its kind from our state chapter. I take this opportunity to thank our Hon'ble President, Prof. Y Nageswara Rao for the initiation of OSSAP Monographs. I congratulate Prof. S. Amarnath (Editor in Chief), Sub-Editors and all authors of individual chapters for striving hard in bringing this extremely rare topic into existence. Hip & Knee Preservation is in itself a complex topic and with the advent of this book, post-graduates can get their basics right.

This Monograph comprises of interesting chapters regarding Joint Preservation of both Hip & Knee, which are produced in a very logistical and economical manner. I would like to recommend this book for all the orthopaedic surgeons for updating their knowledge on Hip & Knee Preservation.

Dr. Naresh Babu J
Secretary, OSSAP

From the Editorial Team...



Dr. Amarnath Surath

Dr. J. Naresh Babu

Dr. Abdul Khan

Dr. P. Lakshmi Narayana

The fourth in the series of OSSAP Monographs has ab unique beginning. We were inundated with finer details of organising the conference at Guntur, making it very difficult to take up the added burden of the monograph. While sorting out topics for the CME on joint preservation, which in itself is a resurgent concept, we felt that the monograph on the same topics will be a good take home message to the deligates. Different aspects of Hip and Knee Preservation have been included with contribution from experienced surgeons.

I thank Dr. V. Dharma Rao, President and Dr. J. Naresh Babu, Secretary for giving me this opportunity. This book has been made possible by a generous grant from Regen Technologies.

Dr Amarnath Surath
Editor - in - chief

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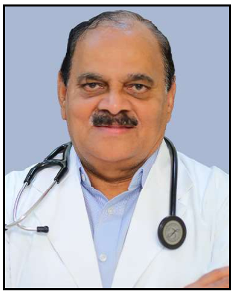
Foreword



It gives me immense pleasure to write the foreward for such an illustrious monograph. The authors have spared no effort to bring out the latest concepts with utmost clarity. The title and subject takes me back in time to the beginning of my practice, some fifty odd years ago. In the seventies orthopaedics was all about osteotomies and joint reconstruction, requiring the skillset of a master craftsmen. The ninties and the millennium saw the advent of aggressive arthoplasty and with time the disadvantages of artificial joints became all too apparent. The new era has seen a resurgence of efforts to preserve natural joints and reconstruct cartilage which is a very healthy trend. Orthobilogics and cellular therapies have turned out to be excellent choices in younger patients. It is my previlage to have seen all these momentous changes in orthopaedics. I congratulate the team for bringing out such an informative monograph.

Dr. Y. Lakshmana Swamy, M.S.
Sanjivi Hospital, Guntur

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ANATOMY AND BIOMECHANICS OF HIP

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Introduction

To address the biomechanical principles involved in the function of the human hip, it is essential to consider the normal anatomy of the proximal femur and pelvis, as the muscles, ligaments, and bony structures all contribute to the equilibrium of forces that allow for controlled motion at the femoral–acetabular articulation.

Anatomy

The hip joint has classically been described as a constrained articulation between the spherical head of the proximal femur and the concave socket of the pelvis called the acetabulum. Together, the femoral head and the acetabulum form a ball-and-socket joint. The articular surfaces of the femoral head and the acetabulum are reciprocally curved but neither coextensive nor completely congruent. Cartilage thickness is maximal anterosuperiorly in the acetabulum and anterolaterally on the femoral head, the two areas that correspond to the principal load-bearing areas within the joint. The acetabular labrum, a fibrocartilaginous rim attached to the acetabular margin, serves to deepen the acetabulum and bridges the acetabular notch by attaching to the peripheral edge of the transverse acetabular ligament. The suction effect due to seal by labrum will maintain the femur head in the acetabulum though the surrounding musculature and ligaments are weak or removed as in cadaver dissections. This depicts the high stability and low range of motion of hip in contrast to shoulder where the reverse is true.

Capsule

The hip joint is surrounded by a thick fibrous capsule that extends from the acetabular rim to the anterior intertrochanteric line on the proximal femur anteriorly, and onto the posterior intertrochanteric line posteriorly Confluent with the hip capsule are 3 reinforcing ligaments that help to stabilize it at the extremes of range of motion. These ligaments include: the iliofemoral ligament (ligament of Bigelow), which extends from the anterior inferior iliac spine to the anterior intertrochanteric line; the pubofemoral ligament which attaches to the superior pubic ramus and inferior femoral neck; and the ischiofemoral ligament, which extends from the ischium around to the posterior femoral neck. (Figure 1)

The normal inclination between the femoral neck and shaft gradually decreases from infancy to skeletal maturity, and has been found to be as high as 150 degrees in the newborn, with normal values at skeletal maturity in the adult hip of 125±5 degrees. In the axial plane the proximal femur has an anterior torsional relationship with respect to its distal femoral epicondylar axis, or anteversion, with the normal amount of anteversion being 12 to 14 degrees.

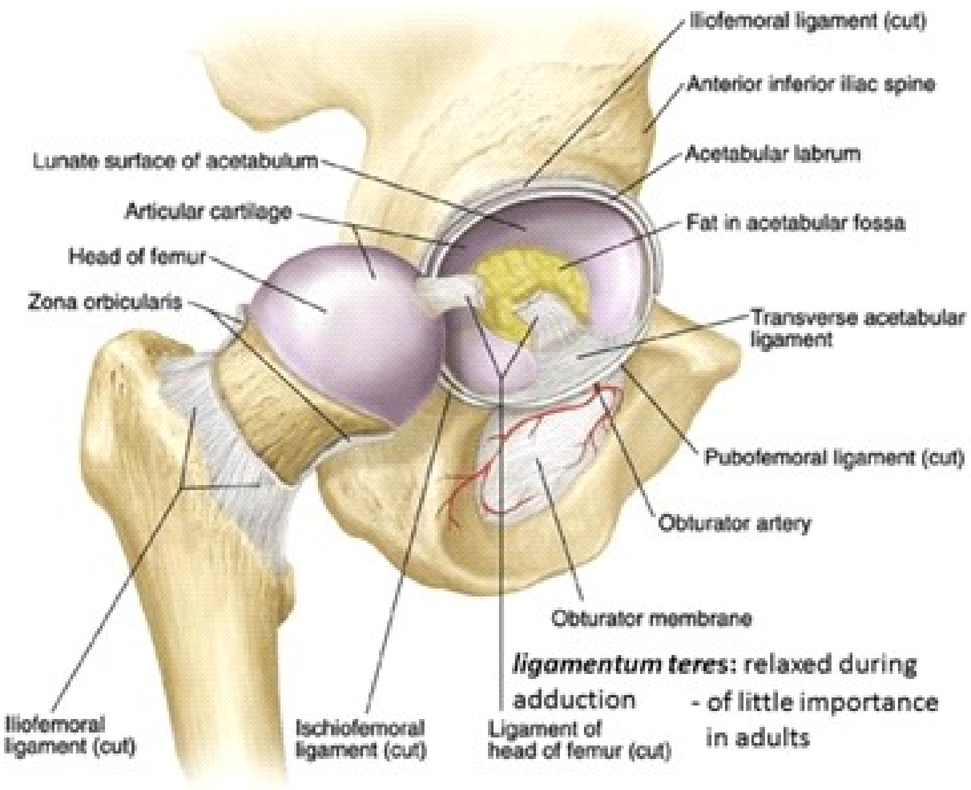


Fig 1 Depiction capsule and labrum of hip joint.

Muscle groups (Figure 2)

The iliopsoas, rectus femoris, sartorius, and tensor fascia lata muscles are responsible for hip flexion. Extension of the hip joint is accomplished with contraction of the gluteus maximus and hamstring groups of muscles (biceps femoris, semimembranosus, and semitendinosus. Contractions of the gluteus medius, gluteus minimus, and tensor fascia lata muscles cause both abduction and internal rotation of the hip joint. Adduction of the hip joint is achieved by contraction of the adductor magnus, adductor longus, and adductor brevis muscles. There are 5 muscles that contribute to external rotation motion of the hip joint : obturator internus, obturator externus , superior gemellus , inferior gemellus , and quadratus femoris .

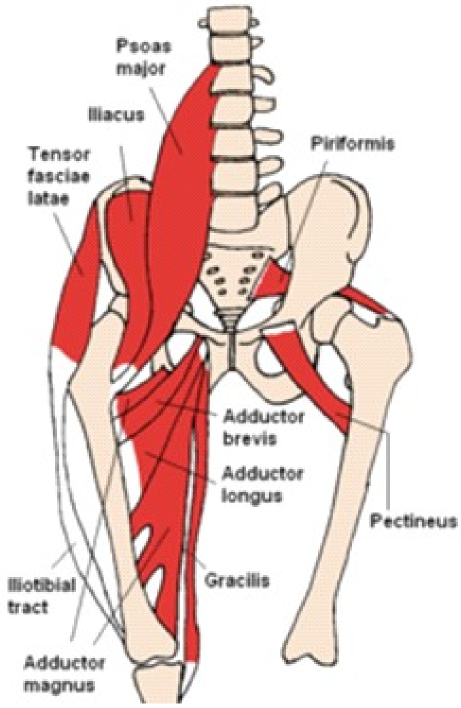


Fig 2 Musculature og Hip and proimal femur.

Vascular supply (Figure 3)

The majority of the blood supply to the proximal femur comes in the terminal branches of the medial circumflex femoral arteries, with lesser contributions from the lateral circumflex artery anteriorly. The acetabulum and acetabular labrum are supplied by branches of the superior gluteal, and inferior gluteal, and obturator arteries.

The vascular ring of the proximal femur consists of a basicervical extracapsular arterial ring, ascending cervical branches, and arteries of the ligamentum teres. The basicervical ring is formed posteriorly by the MFCA and anteriorly by the LFCA. Ascending cervical branch of the MFCA divides into the terminal nutrient arteries to the femoral head. One to five posterior superior nutrient arteries of the femoral head travel under the zona orbicularis, along the femoral neck beneath the reflection of the synovial membrane. Micro angiographic studies have shown that the posterior superior nutrient arteries are approximately 0.8 mm in diameter (range, 0.3 to 1.6 mm).

As the cervical vessels approach the articular margin of the femoral head, a less distinct subsynovial intra-articular arterial ring is formed. This arterial ring is protected by a fibrous sheath and supplies most (approximately 66% to 80%) of the lateral weight-bearing portion of the femoral head. A medial epiphyseal artery with contributions from the MFCA and/or the obturator artery can insert in the fovea through the ligamentum teres to supply the remaining 20% to 33% of the femoral head.

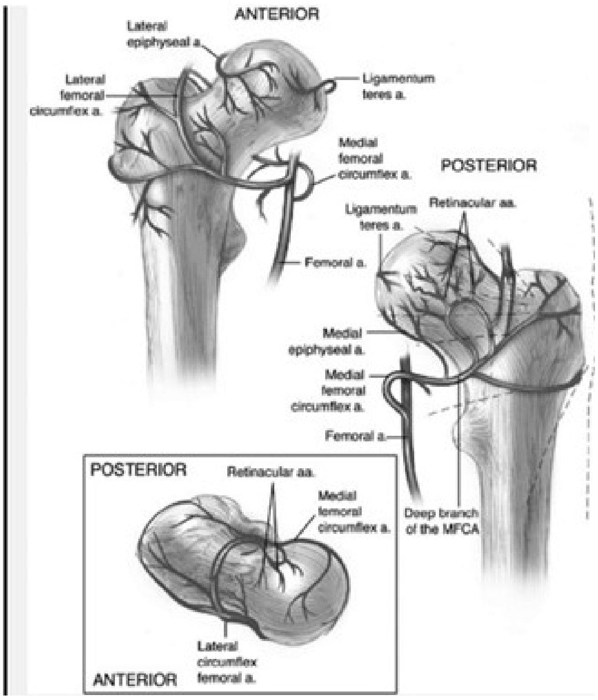


Fig 3 Vasculature of the proximal femur

The frequency of vascular disturbances to the femoral head can be explained by the microvasculature and terminal nature of the sub synovial branches of the MFCA as they run exposed along the femoral neck. Osteonecrosis of the femoral head has been attributed to obstruction of the intraosseous vessels from atraumatic causes or from direct damage.

For avascular necrosis of femoral head sugioka described transtrochanteric osteotomy **(Figure 4)** and femoral head rotation so that unaffected area of femoral head come into weight bearing area in which careful attention is needed for not injuring the vasculature . If it is posterior rotation head can be turned upto 110 – 140 degrees but if it is anterior rotation upto 80 to 100 degrees.

Fig 4 Transtrochanteric rotational osteotomy of the femoral head.

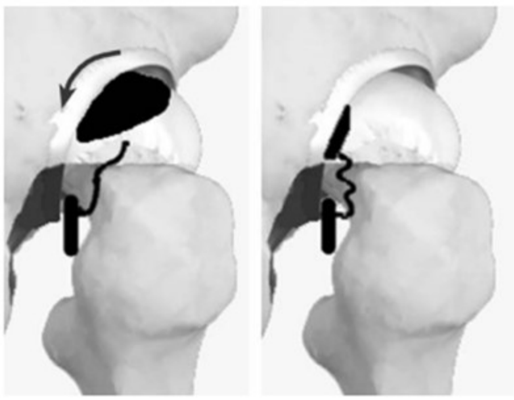
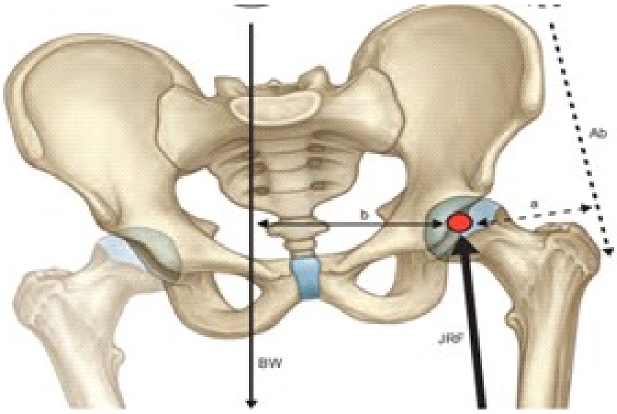


Fig 5 Posterior rotational osteotomy for the treatment of ON of the femoral head.

The tension to the nutrient vessels decreases after the posterior rotation, **(Figure 5)** the femoral head can be rotated by more than 100^0. The upper limit is around 140^0 to 150^0.

Biomechanis of Hip

To describe the forces acting on the hip joint, the body weight can be depicted as a load applied to a lever arm extending from the center of gravity to the center of femoral head. The abductor musculature acting on lever arm extending from the lateral aspect of the greater trochanter to the center of femoral head must exert an equal moment to hold the pelvis level when in a single leg stance and a greater moment to tilt the pelvis to the same side when walking **(Figure 6),** Because the ratio of the length of the lever arm of the body weight to that of the abductor musculature is about 2.5:1, the force of the abductor muscles must approximate 2.5 times the body weight to maintain the pelvis level when standing on one leg **(Figure 7)**. The estimated load on the femoral head in the stance phase of gait is equal to the sum of the forces created by the abductors and the body weight and has been caliculated to be three times the body weight. The load on the femoral head during straight leg raising is estimated to be about the same.



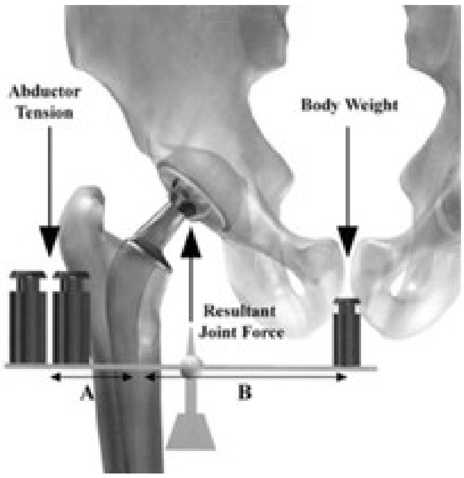


Fig 6, 7 Forces and counterforces acting on hip joint

As integral part of the charnley concept of total hip arthroplasty was to shorten the lever arm of the body weight by deepening the acetabulum and to lengthen the lever arm of abductor mechanism by reattaching the osteotomized greater trochanter laterally. The moment produced by body weight is decreased and the counter balancing force that the abductor mechanism must exert is decreased. It is important to understand the benifits derived from medializing the acetabulum and lengthening the abductor lever arm **(Figure 8).**

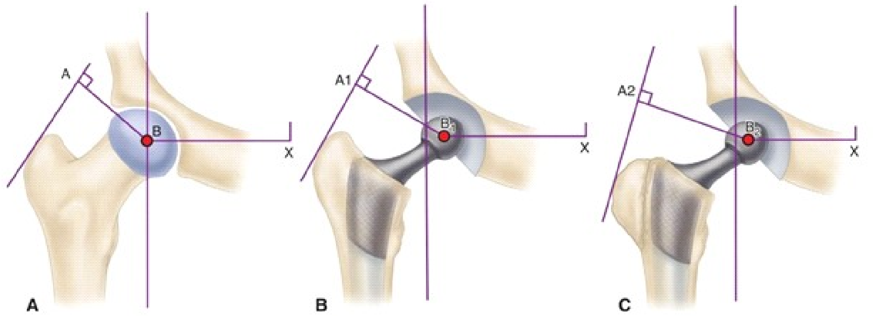


Fig 8 Lever arms acting on hip joint

A. Moment produced by body weightapplied at body 's center of gravity X, acting on lever arm B-X, must be counterbalanced by moment produced by abductors A, acting on shorter lever arm A-B . lever arm A-B may be shorter than normal in arthritic hip. **B** . medialization of acetabulum shortens lever arm B-X, and use of high offset neck lengthens lever arm A-B. **C.** Lateral and distal reattachement of osteotomised greater trochanter lengthens lever arm A-B further and tightens abductor musculature.

AVASCULAR NECROSIS OF FEMORAL HEAD

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Avascular necrosis of femoral head is a debilitating condition affecting the hip joint especially in the younger population and is one of the most common causes of total hip replacement in this age group. The average age of presentation is between 20- 60 years. It is also known as osteonecrosis where aseptic death of segment of femoral head occurs due to interference to blood supply. It can be either traumatic or non-traumatic, resulting in ischemia of a substantial segment of bone

There are many sites most susceptible for osteonecrosis in our body. They lie at the ends of bones and enclosed by articular cartilage, which is avascular and restricts the entry of blood vessels. These subarticular areas sustained largely by end arterioles. The vascular sinusoids which nourish the marrow and bone cells have no adventitial layer and their patency determined by the pressure of the surrounding marrow tissue. The system functions essentially as a closed compartment. Local changes such as stasis, hemorrhage or marrow swelling rapidly leads to vicious cycle of ischemia, reactive edema and inflammation leading to increased intraosseous pressure

There are four different possibilities leading to ischemic necrosis

1. Injury to local blood supply
2. Venous stasis
3. Arterial thrombosis
4. Compression of capillaries and sinusoids

PATHOLOGY

There are four overlapping stages

Stage 1- Bone death -No structural changes

Stage 2- Repair -Early structural failure

Stage 3- Major structural failure

Stage 4- Articular destruction

There are 4 zones of osteonecrosis (FIGURE1)

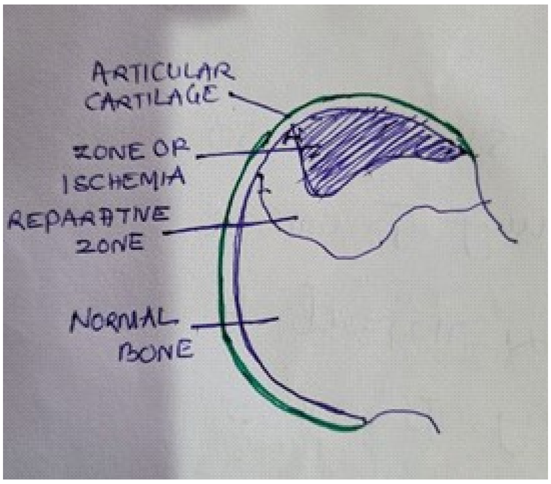

FIGURE 1: ZONES OF STEONECROSIS

Zone 1-Articular cartilage

Zone 2-Zone of ischemia

Zone 3-Reparative zone

Zone 4- Normal bone

NATURAL HISTORY

Ischemia and necrosis

Progression to subchondral fracture

Femoral head collapse

End stage degeneration

CLINICAL FEATURES

- Early stages are painless
- Insidious onset of pain especially in the groin and anterior thigh region and radiating to knee joint, limp and antalgic gait.
- Restriction of movements abduction and internal rotation.
- Sectoral sign is positive (differential rotation).
- Catterall's sign is positive (axis deviation)

INVESTIGATIONS

1.Plain Radiograph- The first step in imaging. Antero-posterior and frog leg lateral views are recommended. Distinctive radiological feature is increased bone density in sub articular segment (snow cap sign).(FIGURE 2)

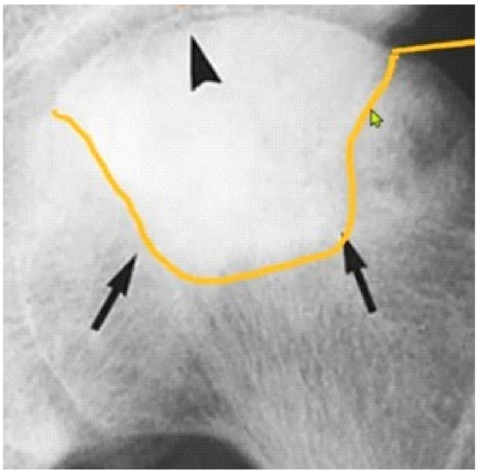

Fig 2: SNOW CAP SIGN AND CRESCENT SIGN

Later changes are subchondral fracture (crescent sign). Femoral head collapse and degenerative changes. The cardinal feature that distinguishes these progressive changes from those of osteoarthritis is that the joint space retains its normal width until late. It may take 2- 6 months for the radiological features to appear. The sensitivity of plain radiograph is 41%

2. MRI-The only reliable method of picking up the early signs of osteonecrosis is by MRI. Its sensitivity is 90-100% and specificity are 100%. Marrow edema in femoral head is earliest finding in MRI. Double line sign(FIGURE 3) in T 2 W images – outer low intensity rim and inner high intensity band. MRI is able to clearly depict the size of the lesion and estimates the stage of the disease. Allows sequential evaluation of asymptomatic lesions.

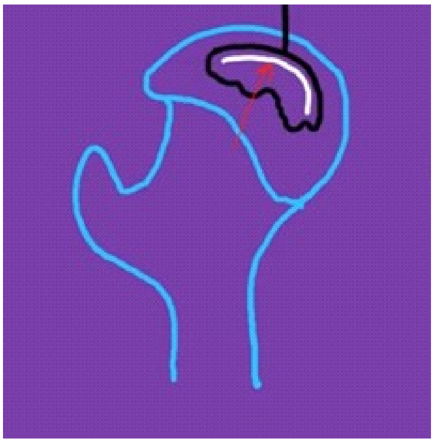

Fig 3: DOUBLE LINE SIGN

3. Bone Scan-Most commonly used isotope Tc 99 is useful where MRI is not feasible such as cardiac pacemakers, intracranial clips

4. CT Scan-Particularly useful to exclude subchondral fracture.

CLASSIFICATIONS

The best treatment for AVN will depend on stage of disease, its location and amount of bone damage. Many classification systems are described to stage the disease. They all are based on clinico radiological findings. The various classification systems are

1. Ficat and Arlet
2. Steinberg Classification
3. ARCO (Association of Research Circulation Osseous System)
4. Mitchell Classification
5. Japanese Investigation Committee (JIC) Classification
6. Kerbouls Classification

FICAT AND ARLET CLASSIFICATION (FIGURE4)

Stage 0

Plain radiograph-normal

MRI- normal

Clinical symptoms-NIL

Stage 1

Plain radiograph-normal

MRI- edema

Bone scan -increased uptake

Clinical symptoms- pain typically in the groin

Stage 2

Plain radiograph-sclerosis

MRI- geographical defect

Bone scan -increased uptake

Clinical symptoms- pain and stiffness

Stage 3

Plain radiograph-crescent sign and cortical collapse

MRI- features same as plain radiograph

Clinical symptoms- pain and stiffness and radiation to knee

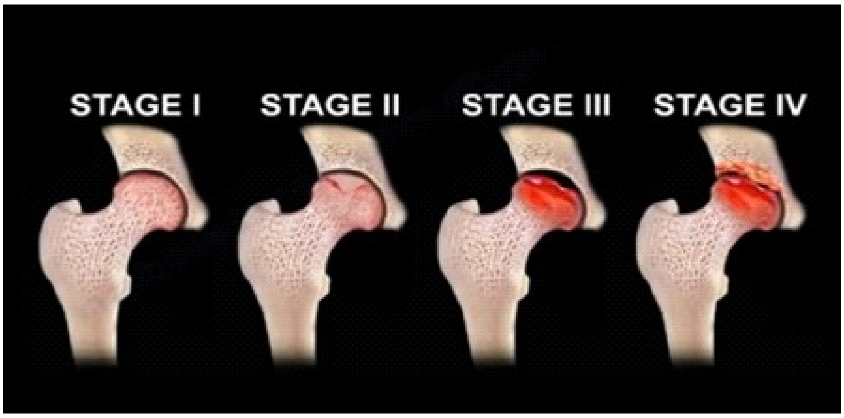

Fig 4 :FICAT and ARLET CLASSIFICATION

Stage 4

Plain radiograph- evidence of secondary degenerative changes

MRI- features same as plain radiograph

Clinical symptoms- pain and limp

This staging is still one of the most commonly used system. The main drawback is it doesn't consider the extent of lesion

STEINBERG CLASSIFICATION

Modification of Ficat and Arlet

Stage 0 - Normal

Stage 1 - Normal Xray

Abnormal MRI

Stage 2- Abnormal Xray -sclerotic changes

Abnormal MRI

Stage 3- Xray-subchondral collapse

Crescent sign

MRI -abnormal

Stage 4- Xray -flattening of femoral head

MRI- abnormal

Stage 5- Xray -joint narrowing

MRI- abnormal

Stage 6- advanced degenerative changes

ARCO CLASSIFICATION

Incorporates features of both Ficat and Arlet and Steinberg classification

MITCHELS CLASSIFICATION

Based on MRI findings

JAPANESE INVESTIGATION COMMITTEE (JIC) CLASSIFICATION

Based on location of necrotic lesion

KERBOULS ANGLE CLASSIFICATION

Is based on the angle of the necrotic lesion

Kerboul Angle

Also known as combined necrotic angle. It is a system used to quantify the size of the lesion. The kerboul angle(FIGURE 5) is the sum of the angles formed by the extent of femoral head lesion and the center of the femoral head on anteroposterior and lateral radiographs

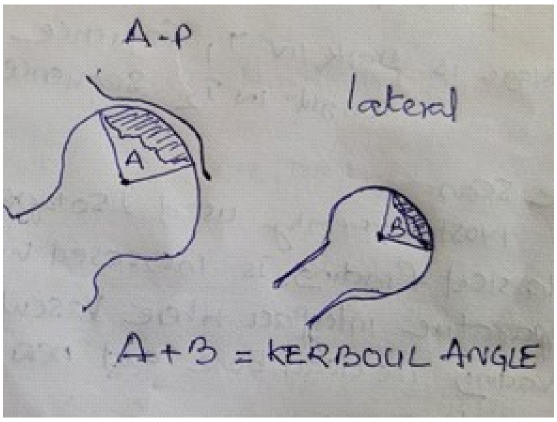

Fig 5: KERBOUL ANGLE

<u>Kerboul's classification</u>

Small- 160^0 or less

Medium -161^0 -199^0

Large -200^0or more

Modified kerboul angle

Uses the angular summation of necrotic lesion in midcoronal and mid sagittal MRI

Modified kerboul's classification

Grade 1- <200^0

Grade 2- 200^0-249^0

Grade 3- 250^0- 299^0

Grade 4->300^0

Significance

Kerboul's angle is a good method to assess future collapse of head in AVN. Also predicts the outcome of various treatment modalities

TREATMENT :

Osteonecrosis is broadly categorized in to 2 types

1. Pre collapsed or early collapsed stage (<2mm collapse)
2. After collapse or degenerative changes

Aim in pre collapsed stage is

- Preservation of head
- Aim for revascularization
- Delay of progression to degeneration After established degeneration
- aim is reconstruction of head

Methods of treatment are basically divided in to Non-Operative and Operative Methods

Non-Operative Methods Are

1. Restricted weight bearing
2. Pharmacological agents
3. Biophysical modalities

Restricted weight bearing-Using crutches or walker. Useful in Ficat and Arlet stage 1 and stage 2, when the Necrotic lesion is <15% and located far from weight bearing zone

Pharmacological agents-Bisphosphonates inhibit osteoclastic activity in the necrotic lesion there by preventing the onset of subchondral fracture and collapse and promotes bone healing. Usually alendronate 70mg/week for 3 years is prescribed but the duration of treatment is yet to be clearly established

Pharmacological agents - anticoagulants statins and vasodilators are also useful in early stages of osteonecrosis to prevent progression from pre collapsed stage to advanced stage.

Biophysical modalities- Extracorporeal shock wave therapy (ESWT), Pulsed electromagnetic therapy, Hyperbaric oxygen. These stimulate the expression of angiogenic growth factors and enhance neovascularization. Hyperbaric oxygen reduces edema by vasoconstriction and induced angiogenesis and improves microvascular circulation

All these useful in Ficat and Arlet stage 1 and stage 2

OPERATIVE METHODS

They are categorized according to the stage of the disease process

Pre collapsed stage of osteonecrosis

Aim of treatment is hip preserving procedures

- Core decompression
- Non vascularized bone graft
- Vascularized bone graft

Core decompression (CD)

Most commonly performed surgical procedure during early avascular necrosis. It decreases the intraosseous pressure and increases the blood flow to the necrotic area. Conventional core decompression is performed by using 8-10mm drill bit. But the results are best when performed with 3.2mm drill bit and when multiple drill holes are made percutaneously at least three. In osteonecrosis there is decreased quantity of endothelial progenitor cells and colony forming units ,and there is impaired migratory capacity of endothelial progenitor cells resulting in decreased angiogenesis . So supplementation of mesenchymal stem cells or growth factor based treatment strategies improves angiogenesis at necrotic bone when combined with core decompression. Intralesional zoledronic acid along with core decompression is also useful in early stages of AVN , to relieve pain, improve movements and delay the progression to collapse and degeneration. After core decompression non weight bearing is advised for 6 to 8 weeks.

Non vascularized bone graft (tibial or fibular)

Auto or allografts are used along with core decompression to support subchondral bone and articular cartilage. They act as osteoconductive and osteoinductive. Three methods are available

1.Phemister technique- grafting through core decompression track

2.Trap door technique- grafting through a window created at femoral head

3.Light bulb procedure- grafting through a window created at femoral head and neck junction

Vascularized bone grafts

Iliac crest vascularized bone grafting

- Vascularized fibular graft
- Muscle pedicle graft -from tensor fascia lata anteriorly
- Quadratus femoris posteriorly

Proximal femoral osteotomy

These techniques move the necrotic bone from the weight bearing region to non-weight bearing region. Their aim is preservation of hip joint. the popular osteotomies are trans trochanteric curved varus osteotomy (TCVO)(FIGURE 6) and trans trochanteric rotational osteotomy (TRO)(FIGURE 7). TCVO was introduced by NISHIU and SUGIOKA and TRO introduced by SUGIOKA.

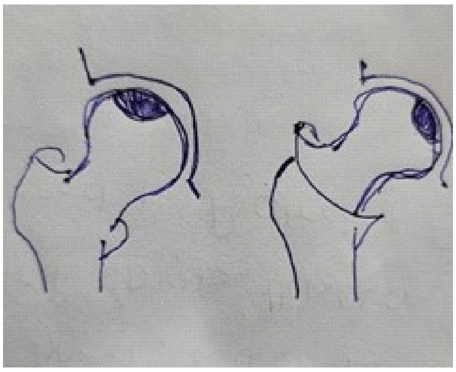

Fig 6:TCVO

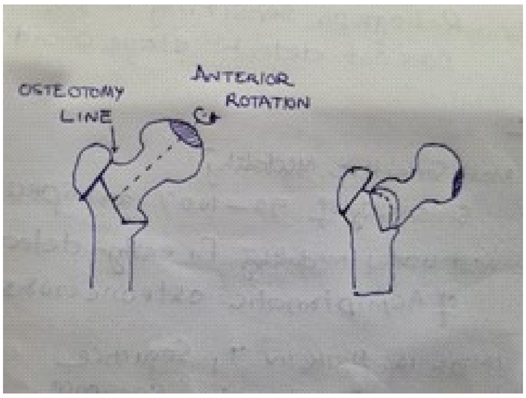

Fig 7: TRO

These osteotomies are useful when patients age is less than 40 years, body mass index is less than24kg/m^2, in Ficat stage 3 and kerboul angle between 190 ^{0}and 240^0 and enough viable bone.

Advanced stages of AVN

The treatment in Ficat stage 4 is essentially the same as for osteoarthritis. Total joint replacement is indicated in these cases. Hip arthrodesis may be considered in young laborers.

PERTHES' DISEASE – MANAGEMENT ALGORITHM

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Legg–Calve–Perthes Disease is characterized by, unilateral or bilateral, avascular necrosis of the femoral head, which affects the range of motion of the hip. In our experience, patients generally report pain in the affected joint, which intensifies during and after physical activity. Sometimes these children will present with complaints of knee pain than hip pain. On the other hand, lameness or Trendelenburg gait is characterized by being the main sign for which they come for consultation. Its incidence is variable, ranging from 0.4/ 100,000 to 29.0/ 100,000 < 15 years old children[1].

Perthes' disease was described over a 100 years ago, but the aetiology of the disease has not been established, and there is no consensus on the optimal treatment. The major emphasis of this article is to highlight a rational approach of treatment, that aims to prevent the femoral head from getting deformed by intervening early in the course of the disease. Treatment options later in the course of the disease have also been mentioned.

Aim of treatment :

Perthes' disease is a self-limiting disease of children characterized by interruption of the blood supply to the capital femoral epiphysis resulting in necrosis of the epiphysis. The vascular occlusion is temporary, complete re-vascularization of the epiphysis occurs over a period of 2-4 years if the child is under 12 years of age at the onset of the disease. During the process of re-vascularization, the necrotic bone is completely replaced by healthy new bone. [2, 3] In some children the disease heals without any sequelae and consequently no treatment is needed in these children. However, treatment is needed in a significant proportion of children in whom the femoral head is likely to get deformed while epiphyseal re-vascularization occurs. Secondary degenerative arthritis is likely to develop in mid-adult life if the femoral head does get deformed.

Pathogenesis and Timing of Femoral Head Deformation:

The bone necrosis that follows the vascular occlusion triggers changes in the soft tissue of the hip joint which include synovitis, articular cartilage hypertrophy and hypertrophy of the ligamentum teres.[4, 5] These soft tissue changes and muscle spasm cause the femoral head to extrude out laterally of the acetabulum. Stresses of weight-bearing and muscular contraction pass across the acetabular margin onto the extruded part of the avascular femoral head. Unlike normal healthy bone, the avascular bone is not capable of withstanding these physiological stresses and the trabeculae collapse; this results in irreversible femoral head deformation. Extrusion appears to be a prime factor that predisposes to femoral head deformation. The greater the extrusion, the greater the propensity for femoral head deformation. If more than 20% of the width of the epiphysis extrudes outside the acetabulum irreversible femoral head deformation is almost inevitable.(5)

The natural evolution of Perthes disease can be clearly identified on plain radiographs. The disease passes through the stages of avascular necrosis, fragmentation, and reconstitution (Stages I-III) before the disease finally heals (Stage IV) (Waldenstrom[6] (Fig.1).The stages of avascular necrosis, fragmentation, and reconstitution can be further divided by Dr Benjamin Joseph et .al into early and late stages [Stages Ia, Ib, IIa, IIb, IIIa and IIIb (Fig. 2] [5].In untreated children femoral head extrusion increases as the disease progresses. In the initial stages of the disease the increase in extrusion is gradual but extrusion abruptly increases in the late stage of fragmentation (Stage IIb), often exceeding the critical 20% (Fig 3). There is evidence that the femoral head deformation occurs during the late stage of fragmentation or in the early part of the stage of reconstitution. This vital knowledge enables us to divide the disease into an early part (i.e., before femoral head deformation begins) and the late part (i.e., after the femoral head has begun to deform). It follows that treatment aimed at preventing femoral head deformation must be instituted in

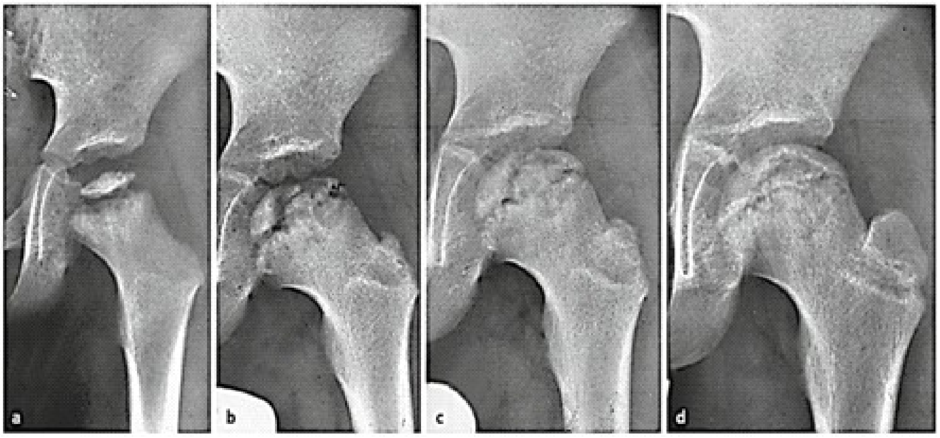


Fig 1. Waldenstrom stages of Perthes disease

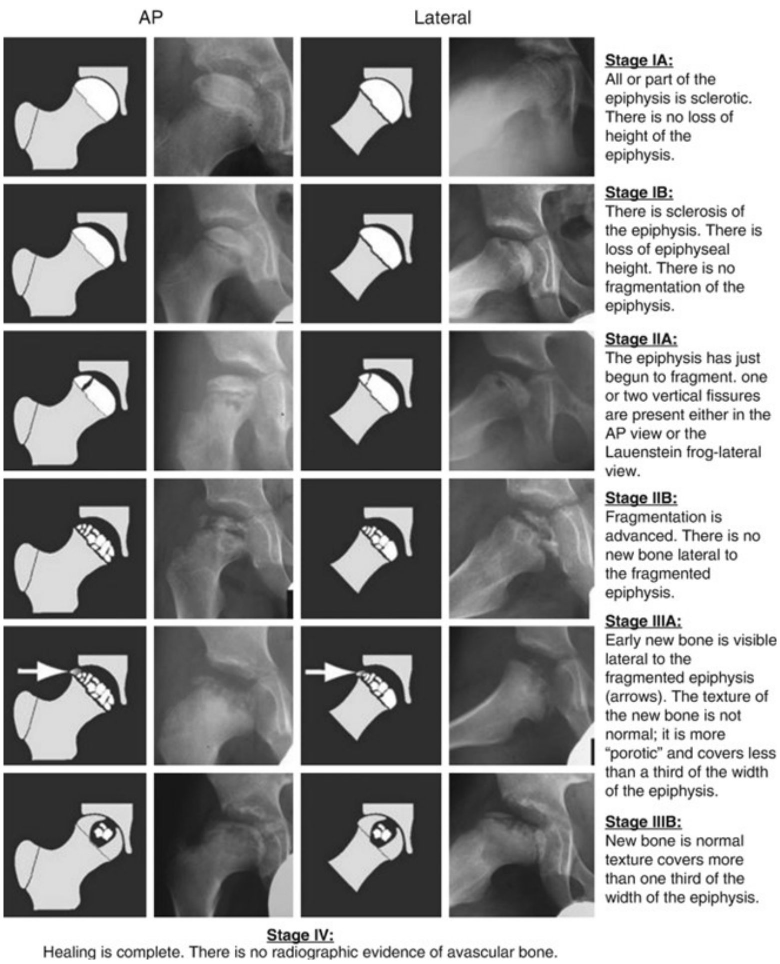


Fig 2. Benjamin Joseph Classification

Fig 3. Femoral epiphysis extrusion

the early part of the disease if it is to be effective. It needs to be emphasized that any treatment instituted at the late stage of fragmentation (Stage IIb) or thereafter is not preventive but either remedial or salvage in nature.

Depending upon the severity of femoral head involvement many classifications are reported in the literature[2,7,8] But Benjamin classification helps us identifying the stage of the disease and same time guides in the management protocol.

Treatment of Perthes' in Early Course of the Disease :

Treatment early in the course of the disease (from the onset to the early stage of fragmentation) attempts to prevent the femoral head from bearing forces across the acetabular margin by either preventing or reversing extrusion of the femoral head by "containment." Containment is the term used to describe any intervention that places the antero-lateral part of the femoral epiphysis well into the acetabulum thereby protecting the vulnerable part of the epiphysis from being subjected to deforming stresses.

Containment can be achieved by two different methods. The first involves keeping the hip in abduction and internal rotation or in abduction and flexion by casting, bracing or by surgery on the femur (Fig. 4). Alternatively, containment can be achieved by an osteotomy of the pelvis that re-orients the acetabulum such that it covers the antero-lateral part of the femoral epiphysis (e.g. Salter osteotomy, triple innominate osteotomy) or by creating a bony shelf over the extruded part of the epiphysis [Fig. 5]. Extrusion invariably occurs sooner or later in children over the age of 7 years at the onset of the disease, and hence containment should be ensured as soon as the disease is diagnosed. In children under 7 years at the onset of the disease extrusion may or may not occur; these children need to be monitored closely with anteroposterior and frog-lateral radiographs, every 3 or 4 months and containment ensured as soon as extrusion is identified without any delay[9]. Most children who are under the age of 5 years at the onset of the disease have a favourable prognosis but some fare badly. Containment will be needed even in these young children if extrusion occurs[10].

Though the importance of containment in the early part of the disease was emphasized repeatedly by several authors this has often been ignored. It is important that their advice is followed as the odds ratio of avoiding femoral head deformation is 16.58 times higher if containment is achieved early in the disease (Stage IIa or earlier) than if it is achieved late in the disease (Stage IIb or later[5] The range of motion should be restored before effective containment can be achieved. Skin traction for a week usually restores motion. If this fails a broom-stick cast in wide abduction can be applied under general anaesthesia and retained for 6 weeks; hip motion improves once the cast is removed. The effect of surgical containment lasts throughout the course of the disease, but the containment effect of bracing or casting is present only as long as the device is worn. Since the propensity for femoral head deformation persists till the early stage of reconstitution (Stage IIIa) the brace or splint must be worn till the disease has progressed beyond this point but need not be continued till complete healing of the disease has occurred. Many advocates avoiding weight-bearing in addition to containment as some reports suggest that combining weight relief with containment may be beneficial.[11]

Treatment Planning :

The factors to take into consideration to decide the treatment include:

- The age of the child at the onset of symptoms
- The presence of extrusion of the femoral head
- The range of motion of the hip
- The stage of evolution of the disease.

Decision making for treatment of Perthes' disease early in the course of the disease :

Children may not qualify for containment based on the decision-making outline shown in **Table 1** these include children who do not need containment as the prognosis is good (e.g., a 6-year-old child in Stage IIa with no extrusion) and children who are denied containment since it is too late for containment to be of benefit (children in Stage IIb or later). Both these groups of children need no active intervention but should be followed up till skeletal maturity to evaluate their outcome. What is the effect of containment? Several studies suggest that children over the age of 6 years at onset of the disease and in whom more than half the epiphysis is avascular are likely to benefit from containment. The chances of retaining a spherical femoral head with minimal coxa magna are greater when containment is performed. Contrary to earlier views that surgical containment has no effect on the healing process, it has been shown that the duration of the disease is significantly shortened with a third of children by-passing the stage of fragmentation when a varus osteotomy is performed in the stage of avascular necrosis. [12]

How much of containment is needed? :

Kim et al. suggested that a modest varus angulation of 10-15° is sufficient to obtain adequate containment by a femoral varus osteotomy [13]. Benjamin Joseph, prefers to create a varus angulation of 20° [Fig. 4].[12, 11] Excellent containment can be obtained with the salter, triple pelvic osteotomy (Fig. 5) however, there is a risk of over-coverage and pincer impingement. The acetabular fragment must not be rotated so far as to increase the CE angle beyond 44° when a triple pelvic osteotomy is performed. 40 There are no studies that attempt to determine how large a shelf is required to provide adequate containment without causing impingement.

Treatment of Perthes' : Late in the Course of the Disease (Remedial Surgery) :

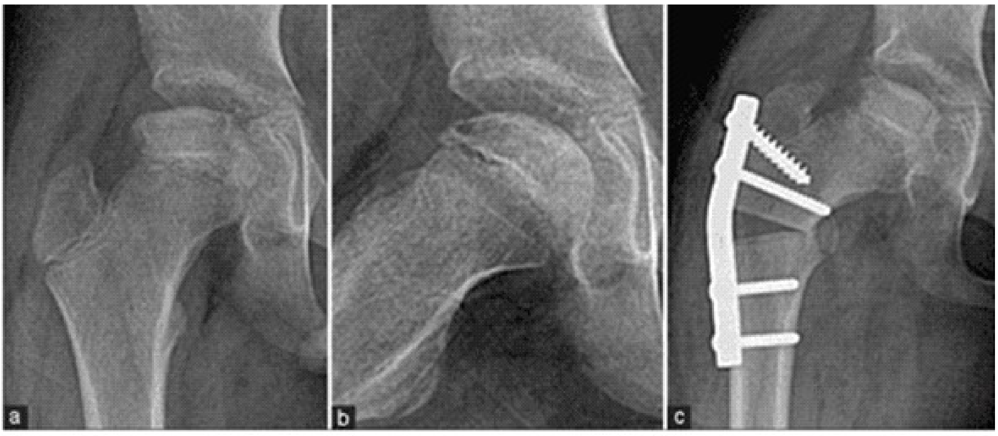
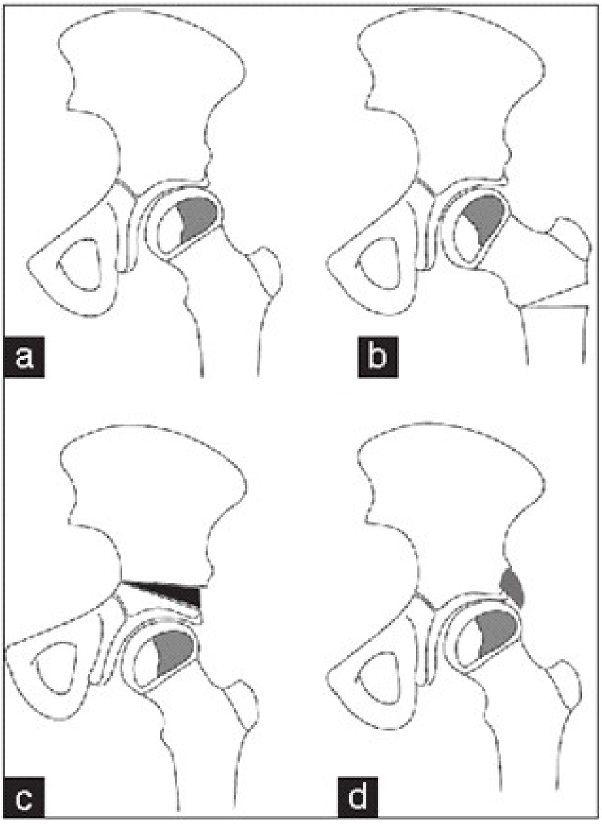


Fig 4. Proximal femoral Varus osteotomy



A.	Extruded avascular femoral epiphysis
B.	Proximal femur varus osteotomy
C.	Salter's innominate osteotomy
D.	Shelf Acetabuloplasty

Fig. 5. Surgical options for hip containment

Treatment in the late part of the stage of fragmentation or in the early part of the stage of reconstitution attempts to minimize the effects of early deformation of the femoral head that has already occurred. At this stage, some children have a reduced range of motion (particularly abduction) and attempted abduction results in hinging. A valgus femoral osteotomy overcomes the hinging and brings a more congruent surface of the femoral head under the acetabulum.[14] The operation should be performed in the advanced stage of reconstitution rather than in the late part of the fragmentation stage because sufficient reconstitution of the femoral head should have occurred enough to withstand weight-bearing stresses without getting deformed. A valgus osteotomy will increase uncovering of the femoral head, and this can be addressed with a shelf procedure. However, the shelf procedure should be delayed in the younger child as the acetabular cover may improve spontaneously once the abnormal forces on the lateral rim of the acetabulum while hinging are relieved by the valgus osteotomy. The valgus osteotomy when performed for hinge abduction relieves pain and improves functional scores but only in a small proportion of hips (~10%) will the femoral head remain spherical and end up as Stulberg Class I or II (spherical head); the majority will fall into Class III and IV (non-spherical). The role of containment at this phase of the disease remains uncertain.

Arthrodiatasis and epiphyseal drilling Apart from containment:

some surgeons have attempted arthrodiatasis or joint distraction with an external fixator in an attempt to unload the hip and facilitate the restoration of epiphyseal height. The reported results have not been sufficiently encouraging to recommend this as the procedure of choice[15]. Yet another approach has been to drill the epiphysis in the hope that this will hasten re-vascularization; reports on the long term outcome of this method of treatment are awaited[16].

Treatment of the Sequelae of the Disease (Salvage Surgery) :

In recent times, there has been enthusiasm to attempt to re-shape the deformed femoral head and the acetabulum following Perthes' disease by safe surgical dislocation of the hip[17]. Abnormalities such as cam impingement, pincer impingement, functional retroversion and greater trochanteric and lesser trochanteric impingement have all been noted and addressed[18]. The surgical procedures performed on young adults are included under what is termed as "joint preserving surgery." Cheilectomy" improves the shape of the femoral head, once the femoral head is irreversibly deformed. It involves removal of the bump on lateral aspect of femoral head[19]. However, there is a risk of joint stiffness after this operation and long-term results are not good. "Greater trochanteric advancement" is indicated in cases where greater trochanter is overgrown and leads to Trendelenburg's gait. This operation helps **in** Reduction of pain, increased joint motion and improved strength of the hip abductors[20].(Table.2)

Survival analysis demonstrated that 61% of the patients had not undergone a total hip replacement 8 years after the surgery, while 39% had already undergone hip replacement by this time. It remains to be seen how much longer the surviving hips will function to decide if these procedures do really preserve the hip. Treatment of established degenerative joint disease following Legg Calve Perthes disease need early Total hip replacement [21].

Table 1. Treatment for Perthes disease in children <12 years

Indications					
< 5 years of age at onset + Any degree of epiphyseal involvement + No extrusion + In stage I,II or III of the disease	< 5 years of age at onset + Half or more of epiphyseal involvement + Extrusion present + In stage I,II of the disease	< 12 years of age at onset + Less than half of epiphyseal involvement + No Extrusion + In stage I,II or III of the disease	5 – 7 years of age at onset + Half or more of epiphyseal involvement + Extrusion present + In stage I,II of the disease	7– 12 years of age at onset + Half or more of epiphyseal involvement + Extrusion present or absent. + In stage I,II of the disease	Under 12 years of age at onset + Half or more of epiphyseal involvement + Extrusion present + In stage III of the disease + Hip Pain
⬇	⬇	⬇	⬇	⬇	⬇
No active intervention Periodic review until healing	Containment with brace in abduction & flexion, abduction & internal rotation	No active intervention Periodic review until healing	Varus derotation femoral osteotomy (if all hip movements are restored) OR Varus extension femoral osteotomy (if Internal rotation limited)	Varus derotation femoral osteotomy (if all hip movements are restored) OR Varus extension femoral osteotomy (if Internal rotation limited) + Trochanteric arrest	Treat pain with rest and traction until pain is relieved + Treat residual problems with salvage procedures

Table 2. Treatment for the sequelae of Perthes disease

Indications				
Healing not compatible or healed disease. + Pain present on abduction + Spherical head + Hip congruent in adduction + Demonstrable hinge abduction ↓	Healed disease + No pain + Large spherical femoral head with uncovering + Hip congruent ↓	Healed disease + No pain + Large flattened femoral head with uncovering + Hip not congruent ↓	Healed disease + No pain + Spherical head + Hip congruent + Coxa breva + Trochanteric overgrowth with Trendelenburg gait ↓	Healed disease + pain + Irregular head + Hip not congruent + Arthritis changes ↓
Valgus Intertrochanteric Osteotomy	Innominate osteotomy or Shelf Operation Or Acetabular augmentation to improve femoral head coverage	Shelf operation or Chiari osteotomy to improve femoral coverage	Trochanteric Advancement =	Arthrodesis

References:

1. Pavone V, Chisari E, Vescio A, Lizzio C, Sessa G, Testa G. Aetiology of Legg-Calvé-Perthes disease: A systematic review. World J Orthop. 2019 Mar 18;10(3):145–65.

2. Catterall A. Legg-Calvé-Perthes syndrome. Clin Orthop Relat Res. 1981;(158):41–52.

3. Salter RB. Legg-Perthes disease: the scientific basis for the methods of treatment and their indications. Clin Orthop Relat Res. 1980;(150):8–11.

4. Joseph B, Pydisetty RK. Chondrolysis and the stiff hip in Perthes' disease: an immunological study. J Pediatr Orthop. 1996;16(1):15–9.

5. Joseph B, Orth M, Ch Orth M, Varghese G, Mulpuri K, Rao L NK, et al. Natural Evolution of Perthes Disease: A Study of 610 Children Under 12 Years of Age at Disease Onset. 2003.

6. The classic. The first stages of

coxa plana by Henning Waldenström. 1938. Clin Orthop Relat Res. 1984 Dec;(191):4–7.

7. Herring JA, Neustadt JB, Williams JJ, Early JS, Browne RH. The lateral pillar classification of Legg-Calvé-Perthes disease. J Pediatr Orthop. 1992;12(2):143–50.

8. Chell J, Flowers MJ. Stulberg classification system. J Bone Joint Surg Am. 2000 Oct;82(10):1517.

9. Canavese F, Dimeglio A. Perthes' disease: prognosis in children under six years of age. J Bone Joint Surg Br. 2008 Jul;90(7):940–5.

10. Fabry K, Fabry G, Moens P. Legg-Calvé-Perthes disease in patients under 5 years of age does not always result in a good outcome. Personal experience and meta-analysis of the literature. J Pediatr Orthop B. 2003 May;12(3):222–7.

11. Joseph B, Srinivas G, Thomas R. Management of Perthes disease of late onset in southern India. The evaluation of a surgical method. J Bone Joint Surg Br. 1996 Jul;78(4):625–30.

12. Joseph B, Rao N, Mulpuri K, Varghese G, Nair S. How does a femoral varus osteotomy alter the natural evolution of Perthes' disease? J Pediatr Orthop B. 2005 Jan;14(1):10–5.

13. Kim HKW, da Cunha AM, Browne R, Kim HT, Herring JA. How much varus is optimal with proximal femoral osteotomy to preserve the femoral head in Legg-Calvé-Perthes disease? J Bone Joint Surg Am. 2011 Feb 16;93(4):341–7.

14. Choi IH, Yoo WJ, Cho TJ, Moon HJ. The role of valgus osteotomy in LCPD. J Pediatr Orthop. 2011 Sep;31(2 Suppl):S217-22.

15. Aly TA, Amin OA. Arthrodiatasis for the treatment of Perthes' disease. Orthopedics. 2009 Nov;32(11):817.

16. Herrera-Soto JA, Price CT. Core decompression for juvenile osteonecrosis. Orthop Clin North Am. 2011 Jul;42(3):429–36, ix.

17. Leunig M, Ganz R. Relative neck lengthening and intracapital osteotomy for severe Perthes and Perthes-like deformities. Bull NYU Hosp Jt Dis. 2011;69 Suppl 1:S62-7.

18. Kim YJ, Novais EN. Diagnosis and treatment of femoroacetabular

impingement in Legg-Calvé-Perthes disease. J Pediatr Orthop. 2011 Sep;31(2 Suppl):S235-40.

19. Rowe SM, Jung ST, Cheon SY, Choi J, Kang K do, Kim KH. Outcome of cheilectomy in Legg-Calve-Perthes disease: minimum 25-year follow-up of five patients. J Pediatr Orthop. 2006;26(2):204–10.

20. Garrido IM, Moltó FJL, Lluch DB. Distal transfer of the greater trochanter in acquired coxa vara. Clinical and radiographic results. J Pediatr Orthop B. 2003 Jan;12(1):38–43.

21. Traina F, de Fine M, Sudanese A, Calderoni PP, Tassinari E, Toni A. Long-term results of total hip replacement in patients with Legg-Calvé-Perthes disease. J Bone Joint Surg Am. 2011 Apr 6;93(7):e25.

DIAGNOSIS AND MANAGEMENT OF SCFE

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Slipped capital femoral epiphysis (SCFE) is a relatively common hip disorder presenting in adolescents with an overall incidence of about 10 cases per 100,000 children.(1,2)

Despite a lot of research in to the etiology of SCFE the exact reason is unclear however it involves both anatomic and metabolic factors.

Antecedents include greater retroversion of the femoral neck or a coxa profunda related to major weakness of the growth plate during the period of rapid growth. On the other hand, metabolic causes implicated in SCFE are obesity some endocrinological diseases, such as hypothyroidism and kidney failure, and treatment with growth hormone. As previously reported, the onset of SCFE usually occurs during the period of maximum growth.

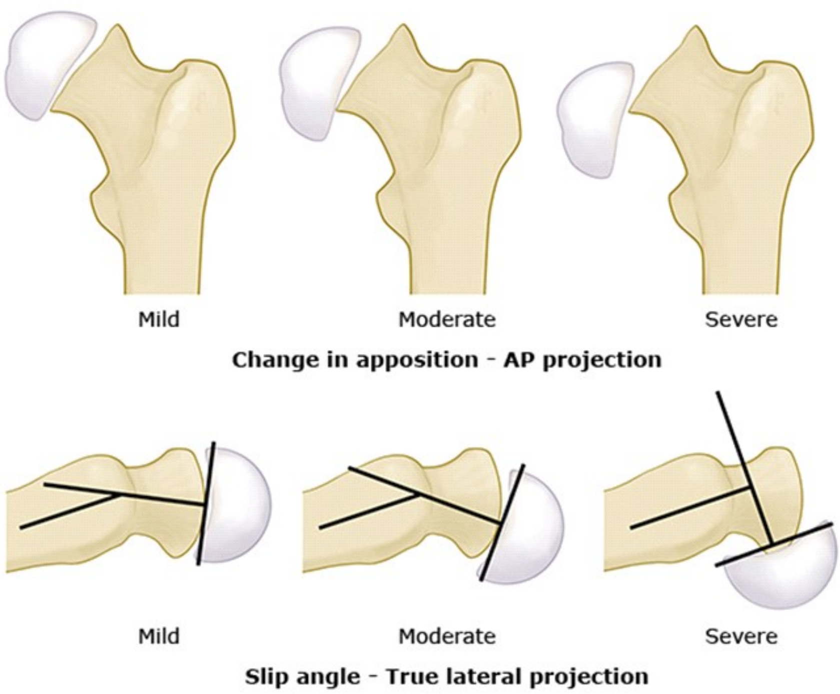
Patients with SCFE show a great variety of presentations and symptoms. Even if a common presentation is that of an obese, hypogonadal boy during adolescent growth, most SCFE cases show no associated endocrine disorder.

Classification :

The most commonly adopted classification divides SCFE into “stable” or “unstable” cases and is based on the ability of the patient to walk.

Radiological classification is based on Southwick’s method to assess the magnitude of the sliding by measuring the angle between the head and femoral diaphysis on X-ray anteroposterior and axial projections.

The angle is then compared with the unaffected side for one-side lesion or with normal values for bilateral involvement (145° in anteroposterior projection and 18° in axial projection). Sliding is defined mild when the angle differs by <30°, moderate if the angle is 30°–60°, and severe if >60°. The Wilson method measures the relative displacement of epiphysis on metaphysis in a frog-leg view, defining degrees of severity in relation to the slip.



Treatment

Treatment of SCFE has been controversial and evolving over the years. The main goals of SCFE treatment are to prevent further slip progression, achieve stabilization and restoration of hip function, and avoid premature hip osteoarthritis while minimizing the risk of AVN and subsequent proximal femoral deformity(3–5)]. Realignment osteotomies have been proposed to restore the proximal femoral anatomy, but historically, AVN complications remain controversial (6). The primary risk associated with osteotomy is damaging the posterior branch of the medial femoral circumflex artery. Therefore aiming to correct deformity and protect the femoral head blood supply, Ganz and his colleagues recently described a modified Dunn osteotomy performed through the surgical dislocation of the hip, which could entirely expose the hip joint protecting the retinacular vessels(7,8)This approach has gained popularity over the past decade in treating moderate to severe adolescent SCFE(9,10). The rationale behind correcting deformity is to prevent femoral acetabular Impingement and future arthrosis and to normalize the hip range of motion. FAI has been associated with increased pain, reduced ROM, chondrolabral damage, and early hip osteoarthritis (9)The retinacular vessels are protected in a periosteal flap during the femoral head reduction with low complications rate after SCFE, ranging from most severe AVN of the femoral head to metaphyseal deformity, which may lead to femoral acetabular impingement and chondral as well as labral damage(11–13).

Procedure :

A 14 year old boy presented to our OPD with history of right groin pain since 45 days and difficulty in walking. He had a history of trivial fall in bathroom 45 days ago for which he didn't take any treatment till he presented to us. On examination the kid was moderately obese with right lower limb in external rotation. He has been walking since then with limp. An x-ray was taken immediately which showed slipped capital femoral epiphysis (Fig 1). No further manipulation or examination was done. An MRI was taken to know the status of contralateral hip if it were in any pre slip stage. Patient was taken up for surgery the next day. Considering the degree of slip Safe surgical dislocation with capital realignment was planned. No attempts at any reduction were made.

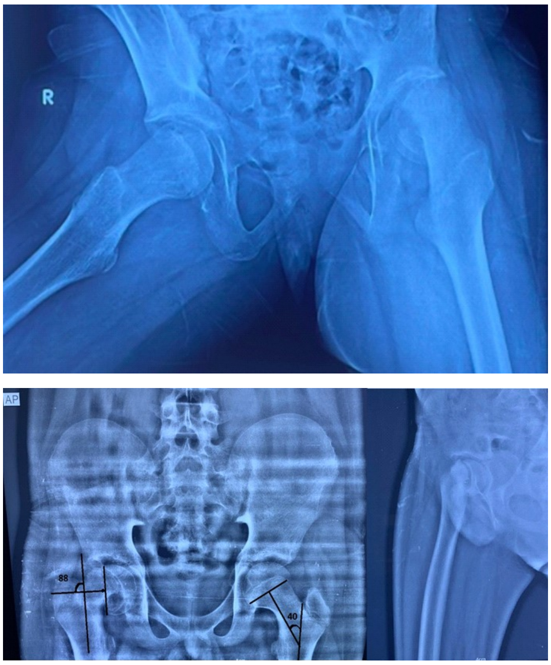


Fig.1 Xrays at presentation showing Slipped capital femoral epiphysis right hip with minimal callus formation

Patient was kept in lateral decubitus position. Straight lateral incision was made centered over trochanter. Subcutaneous tissues and tensor fasica lata were incised in the line of dissection and along anterior border of gluteus maximus and Gibson interval between maximus and medius was developed. Trochanteric bursa was excised and piriformis tendon was identified.

Trochanteric flip osteotomy was made using a saw blade, the osteotomy was performed in such a way the most posterior fibers of gluteus medius were left intact. This ensures that deep branch of medial circumflex femoral artery is left intact. Care was taken to make sure that the trochanteric osteotomy is parallel to the femur and not too inclined to endanger femoral neck. The trochanteric flip was retracted anteriorly leaving behind a stable trochanteric segment posteriorly with piriformis attached to it (Fig 2). Capsule was identified by developing the Gluteus minimus piriformis interval and few fibres of minimus were removed to facilitate capsular exposure.

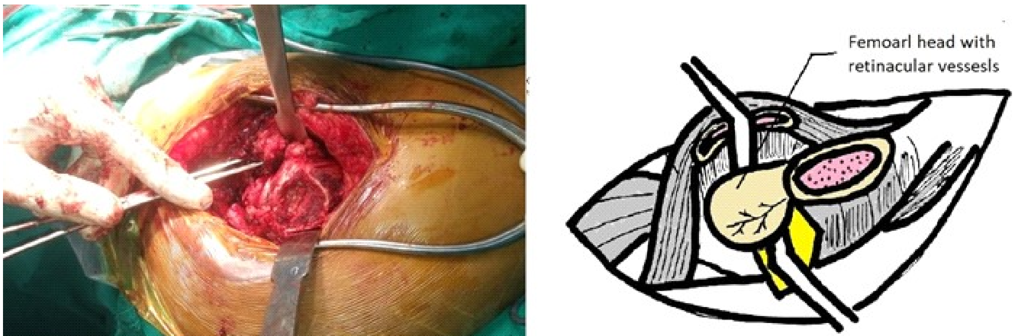


Fig. 2 Intraoperative image showing trochanteric flip osteotomy and dislocated femoral head

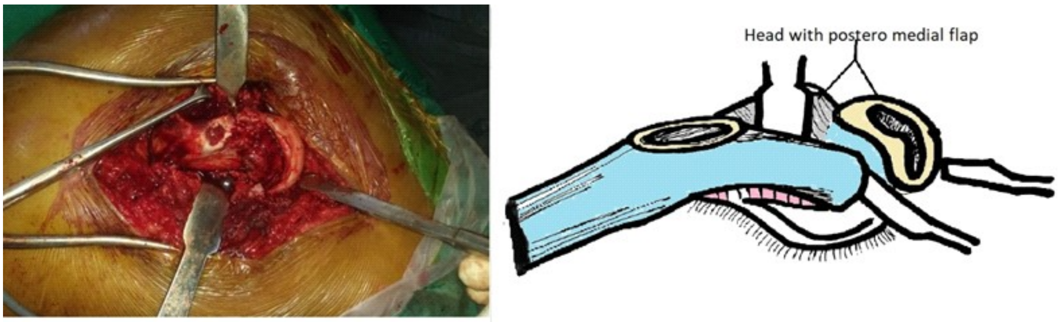


Fig. 3 Intraoperative image showing metaphyseal bump and epiphysis with posteromedial retinacular Flap

Z shaped capsulotomy was made and the metaphyseal bump along with epiphysis were visualized (Fig 3). Head was dislocated by external rotation and gentle traction after provisionally fixing the epiphysis with an 1.8 mm K wire. Viability of head was checked by drilling the articular surface with a 1.8 mm K wire and continuous ooze of blood was noted. Acetabulum was checked for any chondral damage and head was relocated back into acetabulum.

Retinacular soft tissue flap was carefully developed. The flap contains deep branch of medial circumflex femoral artery, periosteum, piriformis and posterior capsule. Cancellous bone was removed from the stable part of greater trochanter to relieve the tension while extending the retinacular flap distally. The retinacular flap was developed till lesser trochanter level by meticulous dissection. Once the retinacular flap was divided attention was then given to the mobilization of epiphysis. Ensuring dissection of the flap till lesser trochanter helps to relieve the tension on the vessels. Epiphysis is gently removed by passing an osteotome through the callus and slowly externally rotating hip (Fig 3). No attempts were made to use force while reducing the epiphysis as this would harm the posterior retinacular vessels. Once epiphysis is separated the metaphyseal bump was carefully remodeled using a high speed burr. Femoral neck was resected for at least 5 mm to facilitate tension free reduction of epiphysis. We believe this is a critical step as any forceful reduction of epiphysis would stretch and damage the posterior retinacular flap. Under direct vision epiphysis was realigned on to the metaphyseal bump and provisionally fixed with a 2 mm k wire passed retrograde from the femoral head articular cartilage. Femoral head was reduced and alignment was checked under C arm (Fig 4). Femoral head was also checked for viability by drilling a 1.8 mm K wire hole, subsequent bleeding was seen which reassured us of the preserved blood supply.. Definitive fixation was done by two 4mm cancellous screws. Capsule was repaired and trochanteric fragment was fixed with 3.5 mm cortical screws (Fig 5). No prophylactic fixation of contralateral hip was done. Post operatively patient was immobilized for 6 weeks. A removable derotation boot was applied to facilitate immobilization of hip.

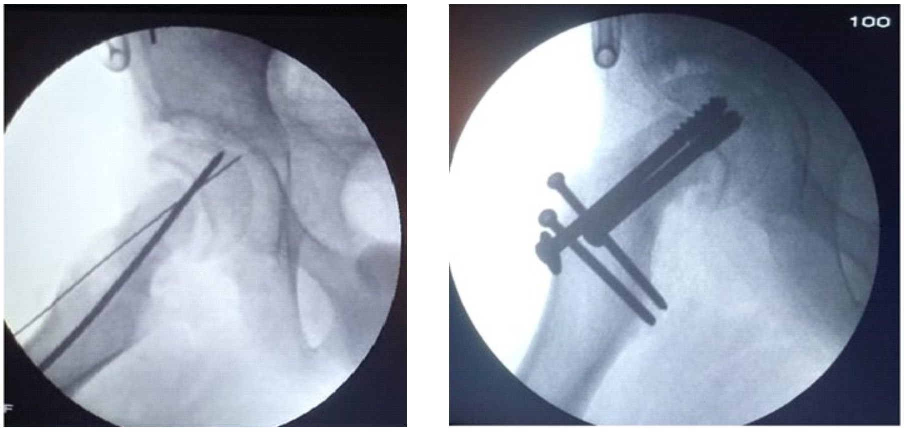


Fig. 4 Intraoperative C arm images showing provisional K wire fixation and definitive fixation

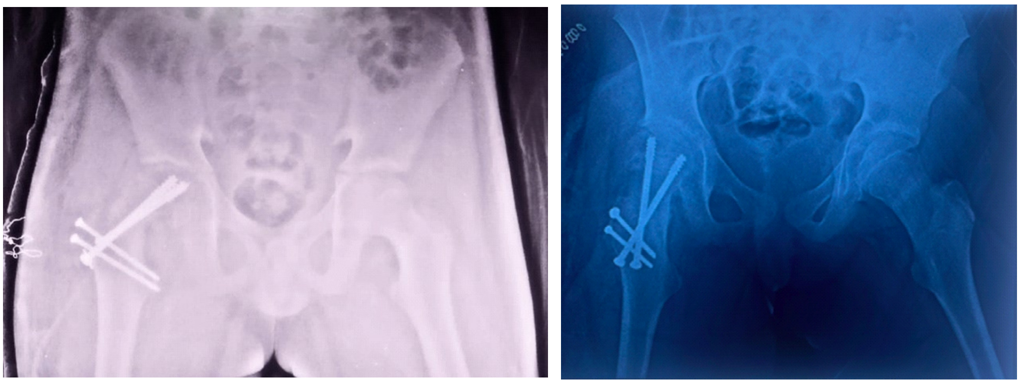


Fig. 5 Final postoperative images showing well reduced epiphysis.

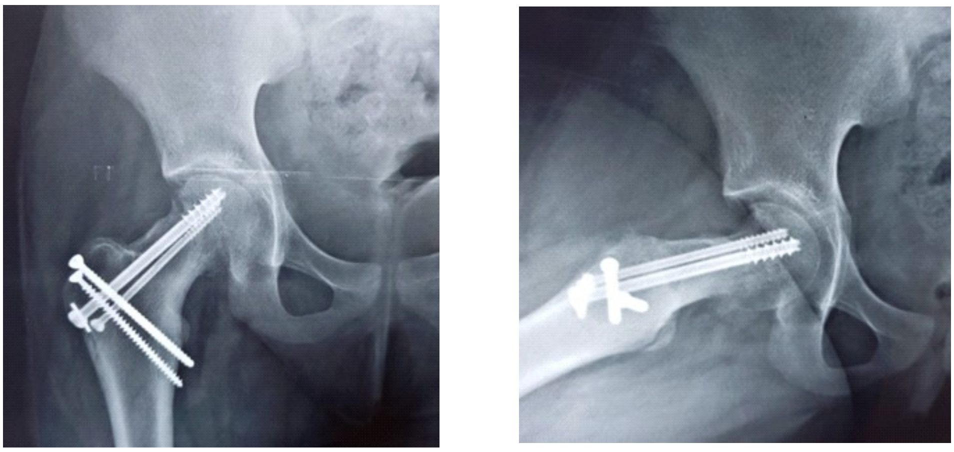


Fig. 6 1 year follow up of severe SCFE treated by the described procedure

Conclusion :

In-situ pinning has been the gold standard for mild SCFE as it ensures minimally invasive fixation of the slip without risk of iatrogenic AVN. Moderate slips can be pinned in situ with or without primary osteochondroplasty. However, treatment of severe SCFE remains a challenging problem. Insitu pinning of a severe slip is not only technically difficult owing to the extreme anterior entry one needs to take and the difficulty in keeping the pin central to epiphysis but it often leads to severe femoro acetabular impingement reduced range of motion, chondrolabral damage and early osteoarthritis.

Various corrective Osteotomies have been proposed to improve hips with a moderate to severe slip. Osteotomies at the base of the neck (14,15) or at the inter-subtrochanteric level (16,17)introduce a distal reverse deformity to restore loss of movement at the hip joint. Only those osteotomies at the level of the physis (7,18) can correct the anatomy and the alignment at the head neck junction. To resolve the above issues, the modified Dunn procedure has been a promising technique that can address both physeal stability and residual deformity with possible lower complication rates in the treatment of SCFE. Capital realignment of SCFE with open physis through the surgical dislocation approach can be performed with low AVN rates. We believe this technique is most appropriate for moderate to severe SCFE and especially for unstable SCFE. The safe execution of this procedure requires a full understanding of the hip's vascular anatomy by the surgeon. This procedure restores the proximal femoral anatomy, and we assume restoration of normal anatomy would lead to good long-term outcomes. This procedure is technically demanding; however, we believe it is worth the investment of effort and skill for a condition that could have lifelong consequences in an otherwise young patient. Several advantages of the modified Dunn procedure have to be mentioned. First, it permits the complete removal of the posteroinferior callus and allows epiphyseal reduction without stretching or kinking of the retinacular vessels. Second, capital realignment and offset at the head-neck junction can be directly visualized. Third, the impingement free movement of the hip can be tested intra-operatively. Fourth, the blood supply to the femoral head can be checked during surgery, and measures for improvement during surgery are possible. And fifth, the correct extra-articular position of all implants can be assured without an image intensifier, thus avoiding intra-articular implant penetration with subsequent chondrolysis. The practice of in situ pinning for any degree of deformity that is widely practiced should be avoided as modified dunns procedure when done with good understanding of vascular anatomy and patience will give better radiological outcomes and moreover the remodeling after insitu pinning in severe slips often is incomplete and leads to severe FAI and further Osteoarthritis.

References :

1. Lehmann CL, Arons RR, Loder RT, Vitale MG. The epidemiology of slipped capital femoral epiphysis: an update. J Pediatr Orthop. 2006 Jun;26(3):286–90.

2. Maffulli N, Douglas AS. Seasonal variation of slipped capital femoral epiphysis. J Pediatr Orthop Part B. 2002 Jan;11(1):29–33.

3. Sankar WN, Vanderhave KL, Matheney T, Herrera-Soto JA, Karlen JW. The modified Dunn procedure for unstable slipped capital femoral epiphysis: a multicenter perspective. J Bone Joint Surg Am. 2013 Apr 3;95(7):585–91.

4. Falciglia F, Aulisa AG, Giordano M, Guzzanti V. Fixation in slipped capital femoral epiphysis avoiding femoral-acetabular impingement. J Orthop Surg. 2017 Oct 30;12(1):163.

5. Tokmakova KP, Stanton RP, Mason DE. Factors influencing the development of osteonecrosis in patients treated for slipped capital femoral epiphysis. J Bone Joint Surg Am. 2003 May;85(5):798–801.

6. Novais EN, Hill MK, Carry PM, Heare TC, Sink EL. Modified Dunn Procedure is Superior to In Situ Pinning for Short-term Clinical and Radiographic Improvement in Severe Stable SCFE. Clin Orthop. 2015 Jun;473(6):2108–17.

7. Dunn DM. THE TREATMENT OF ADOLESCENT SLIPPING OF THE UPPER FEMORAL EPIPHYSIS.J Bone Joint Surg Br. 1964 Nov;46:621–9.

8. Ziebarth K, Zilkens C, Spencer S, Leunig M, Ganz R, Kim Y-J. Capital realignment for moderate and severe SCFE using a modified Dunn procedure. Clin Orthop. 2009 Mar;467(3):704–16.

9. Slongo T, Kakaty D, Krause F, Ziebarth K. Treatment of slipped capital femoral epiphysis with a modified Dunn procedure. J Bone Joint Surg Am. 2010 Dec 15;92(18):2898–908.

10. Huber H, Dora C, Ramseier LE, Buck F, Dierauer S. Adolescent slipped capital femoral epiphysis treated by a modified Dunn osteotomy with surgical hip dislocation. J Bone Joint Surg Br. 2011 Jun;93(6):833–8.

11. Leunig M, Casillas MM, Hamlet M, Hersche O, Nötzli H, Slongo T, et al. Slipped capital femoral epiphysis: early mechanical damage to the acetabular cartilage by a prominent femoral metaphysis. Acta Orthop Scand. 2000 Aug;71(4):370–5.

12. Ganz R, Huff TW, Leunig M. Extended retinacular soft-tissue flap for intra-articular hip surgery: surgical technique, indications, and results of application. Instr Course Lect. 2009; 58:241–55.

13. Rebello G, Spencer S, Millis MB, Kim Y-J. Surgical dislocation in the management of pediatric and adolescent hip deformity. Clin Orthop. 2009 Mar;467(3):724–31.

14. Kramer WG, Craig WA, Noel S. Compensating osteotomy at the base of the femoral neck for slipped capital femoral epiphysis. J Bone Joint Surg Am. 1976 Sep;58(6):796–800.

15. Abraham E, Garst J, Barmada R. Treatment of moderate to severe slipped capital femoral epiphysis with extracapsular base-of-neck osteotomy. J Pediatr Orthop. 1993 Jun;13(3):294–302.

16. Schai PA, Exner GU. Corrective Imhäuser intertrochanteric osteotomy. Oper Orthopadie Traumatol. 2007 Oct;19(4):368–88.

17. Southwick WO. Osteotomy through the lesser trochanter for slipped capital femoral epiphysis. J Bone Joint Surg Am. 1967 Jul;49(5):807–35.

18. Fish JB. Cuneiform osteotomy of the femoral neck in the treatment of slipped capital femoral epiphysis. J Bone Joint Surg Am. 1984 Oct;66(8):1153–68.

ROLE OF CORE DECOMPRESSION IN MANAGEMENT OF AVASCULAR NECROSIS OF FEMORAL HEAD

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Role of Core decompression :

As the name implies, Core decompression is the procedure which involves the removal of bone from the core of the necrotic lesion in the femoral head, so that the increased intraosseous pressure is released. It is an excellent, simple and cost effective treatment in the early stages of disease. By opening up the hard zone that hinders repair, it facilitates vascularisation along the decompression tunnel, enhances replacement of necrotic bone by “creeping substitution” and delays the progression of disease (Kun-Chi Hua et al. 2019). It results in healing of the Avascular region in 97% of patients in stage 1 disease and 77% of patients with stage 2 disease (P Kumar et al.,2020). To improve the outcome, Orthobiologic adjuvants are combined with core decompression.

Types and Technique of Core decompression :

1) Conventional Core decompression was first described by Ficat and Arlet in 1962. The procedure is done under anaesthesia on a fracture table under C Arm Image intensifier guidance. Proper care should be taken during the positioning of patient, so that a good Antero posterior and lateral views of femoral head are obtained. A guide wire is inserted into the centre of the lesion and a trephine is used to remove a core of 8-10 mm of bone (Todd P. Pierce et al. 2015). Complications are the violation of the articular cartilage of femoral head, sub trochanteric fracture, infection, pain, hematoma formation and deep venous thrombosis (Kun-Chi Hua et al. 2019).

2) Multiple percutaneous drilling of the lesion, proposed by Kim et al in 2004, is done using a 3.2 mm drill bit or a 3.6 mm Steinmann pin. In large lesions, 2-3 passes are required. In small lesions, a single pass is sufficient.

3) **Advanced Core decompression**, proposed by Landgraeber et al., involves drilling and removal of necrotic bone using an expandable reamer. A 3.2 mm fluted guide wire is inserted in lesion. X Ream expandable reamer is used to remove necrotic bone 3-5 mm from the subchondral region. Civinni et al used the same technique and filled the bone track with PRO-DENSE, an injectable, hard setting, composite Calcium sulphate and Calcium phosphate bone graft substitute. This material facilitates only Osteoconduction.

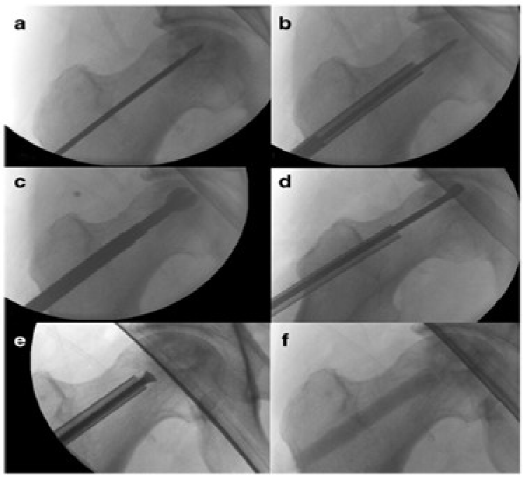

Figure 1: Steps in Advanced core decompression

(Landgraeber et al. BMC Musculoskeletal Disorders (2017) 18:479)

4) Modified advanced Core decompression: A cylinder of autologous bone graft is harvested from the femoral neck using the wire guided trephine. This is impacted into the bone defect in femoral head and the core decompression track. Autologous bone grafting helps in Osteoinduction and Osteoconduction.

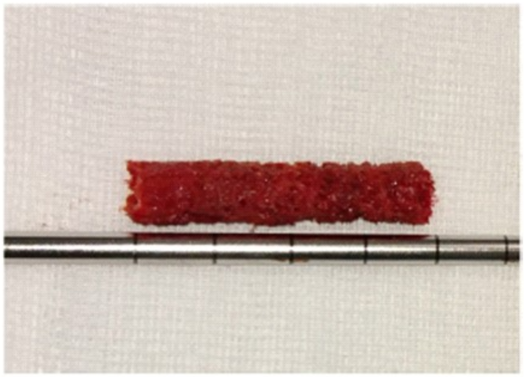

Figure 2 : Cylinder of bone graft harvested from femoral neck

Mechanical Augmentation of Core decompression:

In order to provide support and stability to the weakened necrotic bone and the core decompression track, bone grafts and porous tantalum implants can be used. They prevent or delay the collapse of bone. There are three techniques of bone grafting.

1) Phemister grafting: The graft is morcellised and placed in the core decompression track.

2) Trap door: A window is made at the head and neck junction to insert the bone graft.

3) Light bulb: The bone window is made on the femoral head to insert bone graft.

Non vascularised Bone grafting materials:

Autologous bone graft harvested from the iliac crest, Allografts and Xenografts can be used.

Vacularised Bone grafts:

Vascularised fibular graft is anastomosed to the lateral circumflex femoral artery. Vascularised Iliac crest graft is anastomosed to deep circumflex iliac vessels. They provide mechanical support, scaffold for repair and increase the blood supply to Avascular area. Disadvantages are donor site morbidity and the surgical equipment and expertise needed to perform this surgery.

Porous Tantalum Implants :

Tantalum has the Young's modulus of elasticity similar to human bone. It has 80% porosity by volume. This allows secure and rapid bony ingrowth (Tripathy et al., 2015). Orthobiologics can be combined with this procedure to improve healing.

Role of Arthroscopy :

Arthroscopy of the hip joint can be combined with core decompression procedure. It allows direct visualisation of articular cartilage pathology and facilitates treatment of any coexisting intra articular pathology like Femoro acetabular impingement (FAI). A 3mm K wire is used to make multiple passages (3-5 times) in a fan shaped manner from a single lateral entry point (Ji Li et al.,2017). As the articular cartilage of femoral head is under vision, the risk of breaching the articular cartilage during the process of drilling can be reduced.

Biological Augmentation of Core decompression :

Orthobiologics is the branch of Regenerative medicine in which biological substances found naturally in

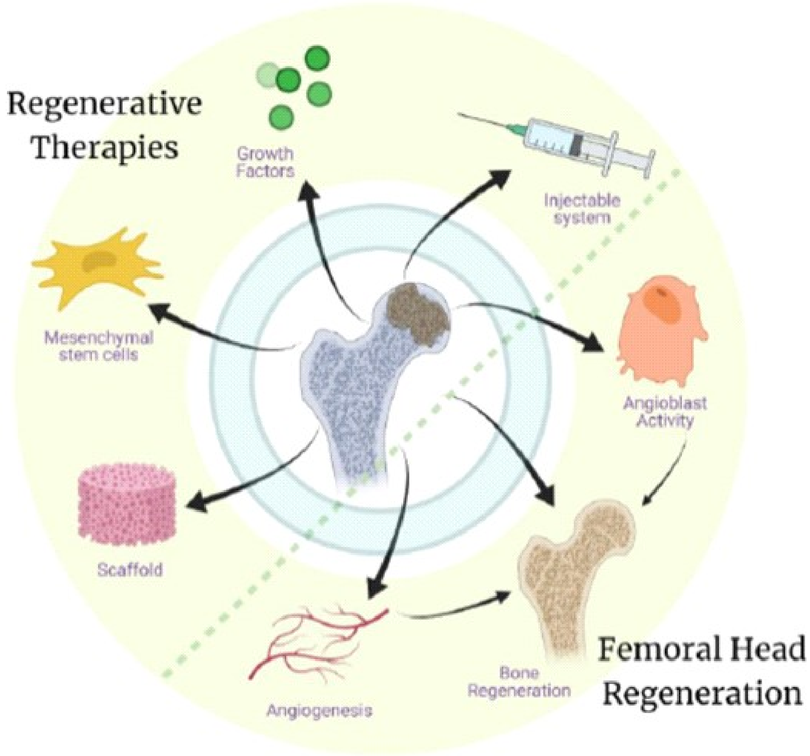

Figure 3: Orthobiologics

the body are used to help injuries to heal more quickly. As the age increases, there is decrease in the number of Colony forming units and increased cellular senescence (Hernigou et al.).

(Murab S, Hawk T Snyder A, Herold S, Totapally M, Whitlock P.W. Tissue Engineering

Strategies for Treating Avascular Necrosis of the Femoral Head. Bioengineering **2021**, 8, 200.)

Various substances like Platelet rich plasma (PRP), Bone marrow aspirate concentrate (BMAC) and adipose tissue derived Stromal Vascular fraction (SVF) are used. Culture and cell expansion techniques can be used to increase the yield. The mesenchymal stem cell (MSC), Bone marrow mononuclear cells, Vascular endothelial cells, Osteoblasts and various growth factors facilitate repair and regeneration. Bone morphogenic protein (BMP) 2 and 7 are used. A dose of more than 50 mg of BMP 2 carries the risk of cancer (Lieberman et al., 2004).

There are no concrete guidelines on the number of cells required and the clinical efficiency of these techniques. Most of the studies were done on small groups without control subjects.

Post operative Protocol :

Patients are advised 50% weight bearing mobilisation on the operated lower limb for the first 6 weeks after surgery. Full weight bearing is allowed after 6 weeks. Strengthening of abductors is advised. They are advised to avoid high impact activities for 1 year. Follow up of patients is advised at 6 weeks, 12 weeks, 6 months and 12 months after surgery.

Conclusion :

Success of the surgical procedure is when there is no radiological progression of disease, the Harris hip score is more than 70 and there is no need for hip arthroplasty. The results of surgery depend on numerous factors like age, stage of disease, presence of risk factors, size of the lesion, location of area of necrosis (Atilla et al.). Medial lesions have better prognosis.

Core decompression is a treatment that can avoid or atleast delay the progression of disease to a point where prosthetic implantation is necessary (Giorgio Maria Calori et al., EFORT open review, 2017).

INTRALESIONAL ZOLEDRONIC ACID (ILZA) IN EARLY AVASCULAR NECROSIS OF HIP-CAN THIS BE THE NEW GOLD STANDARD?

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ABSTRACT

Introduction :

Avascular necrosis (AVN) of hip is a progressive condition often affecting young patients with the end result being secondary arthritis, leading to total hip replacement. AVN of hip gained attention in the recent times because of the exponential rise in the number of cases post COVID. This has been attributed to the liberal use of corticosteroids as lifesaving drugs in covid management[1,2] or due to the hypercoagulable state induced by the disease itself, the exact reasons are yet to be understood. Various treatment modalities ranging from medical management (bisphosphonates) to surgical management (core decompression, hip replacement) are available but Optimal treatment for AVN in various stages are still controversial[3]. As more of younger population are being affected, it is important to focus on preserving the native hip before it is too late to be salvaged. Studies on both non-operative and operative modalities showed variable results. Even different studies on same treatment modality did not yield constant results. The sudden spike in the post covid AVN calls for evaluation of newer and more effective methods to delay the progress of the disease. The current novel technique of intralesional zoledronic acid (ILZA)injection is focused on early avascular necrosis of hip and preventing its progression. **Aims And Objectives**: The objectives of the study are to prevent disease progression, and collapse of the femoral head. ultimately provide pain relief and restore the joint movement. Our study aims to 1. Assess the effectiveness of intralesional zoledronic acid in early avascular

necrosis of hip (Ficat-Arlet 1&2) 2. Assess the clinical outcome following the procedure 3. Assess the quality-of-life post procedure 4. Assess the time delay in the need for surgical intervention and 5. To compare the results with historical control of widely done core decompression procedure.

Methodology :

Ours is a multicentric prospective study. Institutional ethics clearance was taken and informed consent was taken from the patients. All the patients were evaluated clinically and radiologically and diagnosis confirmed. We have included patients with stage 1 and 2 AVN of hip (Ficat and Arlet). The procedure was performed under regional anesthesia under fluoroscopic guidance. The lesion was marked prior to intervention on MRI and extent of avascular area assessed. During the procedure the lesion was identified on C-arm. A 4.0 mm drill bit was passed into the lesion in both AP and lateral views. An 8-gauge Jamshidi needle was passed over the guide wire. Zoledronic acid 4mg powder form was diluted to 5ml and injected through the needle.

Results :

Of the 93 hips diagnosed as avascular necrosis, 20 hips were excluded as they were above stage 2. So, we were left with 73 hips (54 patients). Of the 54 patients, 43(79.63%) were males and 11(20.37%) were females. A total of 35 patients presented with unilateral hip involvement and 19 patients presented with bilateral hip involvement. All the patients had maximum follow-up of 2 years. The mean age group of the study population is 32.3 years (26-45 years). Of the 73 hips,18 hips were in stage 1(24.66%), and 55 hips in stage 2(75.34%). The Harris Hip Score improved from preop average of 59.09(poor) to post op 77.99(fair) at 6 months follow-up and 85.4(good) at 1 year follow-up. The visual analogue scoring improved form preop average of 6.01 to post op average of 1.24 at 1 year follow-up. 67 hips showed good to excellent scores and 6 hips showed poor score at 1 year follow-up. All the patients with unilateral hip involvement fell under fair to good score at follow-up. All the 6 hips which had poor Harris Hip Score at follow-up had bilateral hip involvement. All the 35 patients with unilateral hip involvement had good to excellent outcome be it in stage 1 or stage 2. So far, no patients progressed so as to need for hip replacement. The results were compared with historical control in which core decompression was done with similar study design.

Conclusion :

Intralesional zoledronic acid injection (ILZA) showed superior results to other methods of treatment in stage 1 and stage 2 of AVN and should be considered as a powerful adjuvant to core decompression. The study also dispels the notion that multiple drill holes are necessary for adequate decompression of the avascular area.

Keywords :

Intralesional Zoledronic Acid (ILZA), Avascular Necrosis of Hip (AVN), Harris Hip Score (HHS), Visual Analogue Score (VAS)

INTRODUCTION

Covid has left behind its scar on orthopaedic surgery in the form of AVN of hip. Avascular necrosis (AVN) of hip is a progressive condition often affecting young patients with the end result being secondary arthritis, leading to total hip replacement. AVN of hip gained attention in the recent times because of the exponential rise in the number of cases post COVID. This has been attributed to the liberal use of corticosteroids as lifesaving drugs in covid management[1,2] or due to the hypercoagulable state induced by the disease itself, the exact reasons are yet to be understood. More cases of younger population are reporting with AVN of hip post covid. Various treatment modalities ranging from medical management (bisphosphonates) to surgical management (core decompression, hip replacement) are available but Optimal treatment for AVN in various stages are still controversial[3]. As more of younger population are being affected, it is important to focus on preserving the native hip before it is too late to be salvaged. Studies on both non-operative and operative modalities showed variable results. Even different studies on same treatment modality did not yield constant results. The sudden spike in the post covid AVN calls for research in to best available modalities for tackling the situation. Many studies are suggesting the promising role of bisphosphonates in the treatment of AVN hip[4,5,6,7] but with limited follow-up or less study population. Currently bisphosphonates are administered systemically (either orally or intravenously). The 3rd generation bisphosphonate zoledronic acid has higher affinity to bone compared to other bisphosphonates which is being administered intravenously for various skeletal conditions[11]. Bisphosphonates are also being incorporated on to the implants or coated on to the implant surface to prevent bone resorption and actively promote bone regrowth to extend the durability of implants [12,13,14,15,16,17,18,19] .This suggested the current novel technique of intralesional zoledronic acid (ILZA)injection in early avascular necrosis of hip to achieve high local concentration of the drug and prevent osteoclast mediated resorption, enhance the osteo-anabolic effect and thereby preventing the progression of the disease

AIMS AND OBJECTIVES

The objectives of the study are to prevent disease progression, and collapse of the femoral head. ultimately provide pain relief and restore the joint movement with ILZA. Our study aims to 1. Assess the effectiveness of intralesional zoledronic acid in early avascular necrosis of hip 2. Assess the clinical outcome following the procedure 3. Assess the quality-of-life post procedure 4. Assess the time delay in the need for surgical intervention and 5. To compare the results with historical control of widely done core decompression

MATERIALS & METHODS

Ours is a prospective multicentric study conducted over a period of 2 years from January 2021 to January 2023. Institutional ethics clearance was taken prior to the study. Informed consent was taken from all the study population prior to the procedure. A total of 66 patients (93 hips) were diagnosed with AVN hip during the study period. Of the 66 patients 12 patients (20 hips) were excluded from the study as they were more than stage 2 involvement. So, we were left with 54 (73 hips) patients who were included in the study. Of the 54 patients 43 were male and 11 were females. We included cases with both unilateral and bilateral involvement. A total of 73 hips were included in the study. All the patients were evaluated clinically and radiologically and diagnosis confirmed. we included patients with stage 1 and stage 2 AVN hip (Ficat & Arlet classification). Patient with blood dyscrasias, platelet dysfunction, collagen vascular disorders, malignancies, previous infection to hip joint, previous intra articular steroid injection, history of trauma to hip joint were excluded from the study. Surgical evaluation was done and patient posted for the procedure. The preoperative Harris Hip Score and Visual Analogue scale are documented. The procedure was done under regional anaesthesia, under fluoroscopic guidance. The avascular area was marked prior on MRI. Approximately 1 cm incision (Figure 4) was made centering the flare of greater trochanter. A 4mm drill (Figure 2) was passed

Fig 4 : Intra Operative Picture Showing Less Than 1 Cm Incision

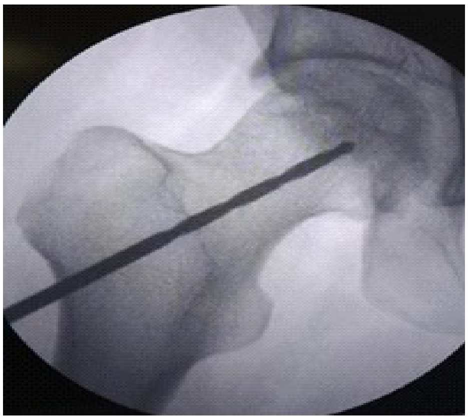

Fig 2 : Placing Drill Bit In To The Avascular Area Under Fluoroscopic Guidance

aiming at the avascular area. The position of drill was checked in both Antero-posterior and lateral views. In the initial few cases the spread of the drug was checked by injecting (Iohexol) dye and confirming its spread into the lesion. The drill bit was withdrawn and guide wire was placed. An 8-gauge Jamshidi needle (15 cm length) (Figure1,3) was inserted on to the guide wire and the

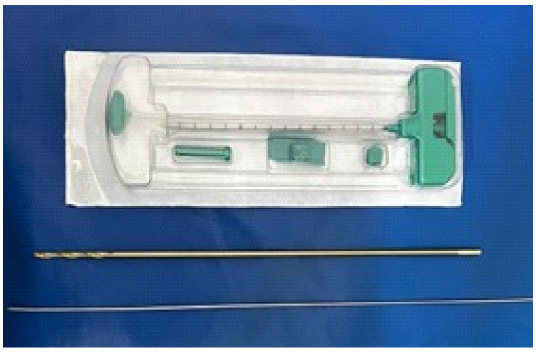

Fig 1 : 8G- Jamshidi Needle And Drill Bit Used For The Procedure

Fig 3 : Inserting Jamshidi Needle Over The Guide Wire

needle was advanced into the avascular area. 4 mg of zoledronic acid powder was dissolved in 5 ml normal saline and injected in to the avascular area. The back flow was prevented by inserting the stylet in to the needle and it was left in place for around 10 minutes. Post operatively the patient was followed up every 4 weeks. All the patients were advised toe touch walking with frame for 6 weeks. Post operatively Harris Hip Score and Visual Analogue Scale was documented at 1,3- and 6-months interval for up to 2 years. At the follow-up patients were assessed for the progression or improvement of the stage of avascular necrosis both clinically and radiologically. The results were compared with historical control of widely done core decompression procedure.

RESULTS

Of the 93 hips diagnosed as avascular necrosis, 20 hips were excluded as they were above stage 2. So, we were left with 73 hips (54 patients). Of the 54 patients, 43(79.63%) were males and 11(20.37%) were females. A total of 35 patients presented with unilateral hip involvement and 19 patients presented with bilateral hip involvement. All the patients had follow-up of 2 years. The mean age group of the study population was 32.3 years (26-45 years). Of the 73 hips,18 hips were in stage 1(24.66%), and 55 hips in stage 2(75.34%). The kerboul angle was measured on preoperative radiographs and it averaged to 149.09 degree(112-198 degrees). Majority of the cases (43 hips) in the study group fell under small lesion (<160 degrees of kerboul angle) The Harris Hip Score improved from preop average of 59.09(poor) to post op 77.99(fair) at 6 months follow-up and 85.4(good) at 1 year follow-up (Table 1). The visual analogue scoring improved form preop average of 6.01 to post op average of

1.24 at 1 year follow-up. 67 hips showed good to excellent scores and 6 hips showed poor score at 1 year follow-up (Table 2). All the patients with unilateral hip involvement fell under fair to good score at follow-up. All the 6 hips which had poor Harris Hip Score at follow-up had bilateral hip involvement. All the 35 patients with unilateral hip involvement had good to excellent outcome be it in stage 1 or stage 2. So far, no patients progressed so as to need for hip replacement. The results were compared with historical control in which core decompression was done with similar study design.

DISCUSSION

It is almost a century ago that osteonecrosis was first described by Haenisch [21] in the year 1925, but the optimal treatment in various stages of avascular necrosis of hip still remains controversial. Over the decades various treatment modalities ranging from medical management to surgical procedures have been described but with inconsistent results. Every surgeon tends to go by their experience of what worked best for them. Currently Core decompression has been widely used by surgeons as the standard procedure. The conventional method of core decompression involves single 8–10 mm core removal to decompress the femoral head, but it has been documented to be associated with complications such as risk of iatrogenic subtrochanteric fracture, inadequate decompression as well as risk of chondral injury[23,24]. The current spike of post covid AVN especially in younger population calls for evaluation of newer and more effective methods which can effectively delay the progression of the disease. Previously oral and intravenous bisphosphates have been tried but they need prolonged administration and very limited studies are available with long term follow-up. A study by **Agarwal et al**[25] where 53 hips were followed up to 10 yrs following oral bisphosphonate therapy, showed collapse rate of as low as 29%. The study by **Agarwal et al**[25] suggested that bisphosphonates can have promising results but the challenge is in developing an ideal mode of administration to have an effective local concentration of the drug, with better patient tolerability, less systemic side effects and effective outcomes. Ours is the largest study population in literature with 73 hips being treated with minimally invasive single dose intralesional zoledronic acid injection with favorable results. The bisphosphonates act by inhibiting the osteoclast mediated bone resorption as well as by osteo-anabolic effect. Zoledronic acid is a 3rd generation bisphosphonate which has highest bone affinity compared to rest of the bisphosphonates. Zoledronic acid binds to the calcified matrices such as hydroxyapatite phase of mineralized bone there by preventing the attachment of more mature osteoclastic precursors to bone surface. The adsorption affinity of different bisphosphonates have been determined in vitro as(clodronate0.6< etidronate 1.2< risedronate 2.2<ibandronate 2.4<alendronate 2.9<zoledronate 3.5 l/mol $*10^{6}$.). this suggests that zoledronic acid will have better uptake, better retention in the skeleton, and diffusion of drug in to the bone. This will have good effect on mineral dynamics and bone cellular function compared to other bisphosphonates. Our technique will have the combined effect of core decompression and locally delivered bisphosphonates. Thus, having the benefits of both the procedures yet being minimally invasive with lesser side effects.

Our study results are superior when compared with results of **Lavernia et al**[9]. (Table 3) The improvement between preoperative HHS and postoperative HHS is more than 3 times in our study. In the study by **Lavernia et al**[9] they followed the standard core decompression technique as the sole modality of treatment and they included avascular necrosis up to stage 3. But the worsening of the disease both clinically and radiographically was significant in all the 3 stages in their study. The study population is also less when compared to our study.

Our study results (post op HHS) are comparable to study by **Powell et al**[1] (Table3) but our study population is large when compared to their study. Our study has majority of the hip classified as stage 2 AVN (75.34%) and the rest of them are stage 1 AVN (24.66%). Where as in the study by **Powell et al**[1] **only** 11 hips out of 34 hips were of stage 2 (32.35 %) and rest were stage 0 and stage 1. So, our results are superior to the standard core decompression procedure.

Our study results are similar to that of **Mont et al**[10] (Table 3) where multiple small drill holes are made to decompress the femoral head. The preoperative and postoperative HHS were similar but the study by **Mont et al**[10] had less study population compared to our study and majority of their study group 66.66% were in stage 1 AVN. This confirms our study which has more study population in stage 2 AVN had superior results with ILZA. It also goes to show that single or multiple drill holes in to the avascular area have a similar effect in decompressing the femoral head

CONCLUSION

Intralesional zoledronic acid injection (ILZA) showed superior results to other methods of treatment in stage 1 and stage 2 of AVN and should be considered as a powerful adjuvant to core decompression. The study also dispels the notion that multiple drill holes are necessary for adequate decompression of the avascular area.

Table1 : Study Results

Preop HHS	**59.09**	**PREOP VAS**	**6.01**
HHS AT 6MONTHS	**77.99**	**VAS AT 6MONTH**	**2.78**
HHS AT 1 year	**85.4**	**VAS AT 1 year**	**1.24**

Table 2 : HHS At Follow-up

HHS	PATIENTS AT FOLLOWUP
90-100(EXCELLENT)	**13(17.81%)**
80-90(GOOD)	**54(73.97%)**
70-80(FAIR)	**6(8.22%)**
<70(POOR)	**0**

Table 3 : Comparison of Results with Other Studies

COMPARISION	PRE-OP HHS	POST OP HHS	IMPROVEMENT
OUR STUDY (73 HIPS)	59.09	85.4	26.31
Powell et al[8] (34 HIPS)	41	85	44
Lavernia et al[9] (64 HIPS)	49.8	58.5	8.7
Mont et al[10] (45 hips)	59	85	26

REFERENCES

1.Beware of Steroid-Induced Avascular Necrosis of the Femoral Head in the Treatment

of COVID-19—Experience and Lessons from the SARS Epidemic. Shenqi Zhang,1,2,3

Chengbin Wang,3 Lei Shi,1 and Qingyun Xue1,2.

2. Agarwala SR, Vijayvargiya M, Pandey P. Avascular necrosis as a part of 'long COVID19. BMJ Case Rep. 2021 Jul 2;14(7), e242101.

3. Sanjay Agarwala, MS (Orth), MCh (Orth),* and Satyajit B. Shah, MS (Orth) Ten-Year Follow-Up of Avascular Necrosis of FemoralHead Treated With Alendronate for 3YearsThe Journal of Arthroplasty Vol. 26 No. 7 2011

4. Agarwala S, Sule A, Pai BU, et al. Study of alendronate in avascular necrosis of bone. J Assoc Phys India 2001;49:949.

5. Agarwala S, Jain D, Joshi VR, et al. Efficacy of alendronate,a bisphosphonate, in the treatment of AVN of the hip. A prospective open-label study. Rheumatology (Oxford) 2005;44:352 Epub 2004 Nov 30. Erratum in: Rheumatology (Oxford). 2005 Apr;44:569.

6. Agarwala S, Sule A, Pai BU, et al. Alendronate in the treatment of avascular necrosis of the hip. Rheumatology (Oxford) 2002;41:346.

7. Lai KA, Shen WJ, Yang CY, et al. The use of alendronate to prevent early collapse of femoral head in patients with non traumatic osteonecrosis. A

randomized clinical study. J Bone Joint Surg Am 2005;87:2155.

8.Powell ET, Lanzer WL, Mankey MG. Core decompression for early osteonecrosis of the hip in high risk patients. Clin Orthop Relat Res. 1997;335:181-9.

9. Lavernia CJ, Sierra RJ. Core decompression in atraumatic osteonecrosis of the hip. J Arthroplasty. 2000;15:171-8.

10. Mont MA, Ragland PS, Etienne G. Core decompression of the femoral head for osteonecrosis using percutaneous multiple small-diameter drilling. Clin Orthop Relat Res. 2004;429:131-8.

11. Zoledronic Acid A Review of its Use in the Management of Bone Metastases and Hypercalcaemia of Malignancy Keri Wellington and Karen L. Goa Adis International Limited, Auckland, New Zealand Drugs 2003; 63 (4): 417-437

12. Bobyn JD, Thompson R, LimL, Pura JA, Bobyn K, TanzerM. Local alendronic acid elution increases net periimplant bone formation: a micro-CT analysis. Clin Orthop. (2014) 472:687–94. doi: 10.1007/s11999-013-3120-6

13. Gao Y, Zou S, Liu X, Bao C, Hu J. The effect of surface immobilized bisphosphonates on the fixation of hydroxyapatite-coated titanium implants in ovariectomized rats. Biomaterials. (2009) 30:1790–6.

14. Hilding M, Aspenberg P. Postoperative clodronate decreases prosthetic migration: 4–year follow-up of a randomized radiostereometric study of 50 total knee patients.Acta Orthop. (2006) 77:912–6.

15. Greiner S, Kadow-Romacker A, Lübberstedt M, Schmidmaier G, Wildemann B. The effect of zoledronic acid incorporated in a poly(D,L-lactide) implant coating on osteoblasts in vitro. J Biomed Mater Res A. (2007) 80A:769–75.

16. HildingM, Aspenberg P. Local peroperative treatment with a bisphosphonate improves the fixation of total knee prostheses: a randomized, doubleblind radiostereometric study of 50 patients. Acta Orthop. (2007) 78:795–9.

17. Qayoom I, Raina DB, Širka A, Tarasevi¡cius Š, Tägil M, Kumar A, et al. Anabolic and antiresorptive actions

of locally delivered bisphosphonates for bone repair: a review. Bone Jt Res. (2018) 7:548–60.

18. Ryabov A, Lekishvili M. Local application of bisphosphonates for osteosynthesis: a literature review. J Tissue Sci Eng. (2016) 7:172.

19. Khamis AK, Elsharkawy S. The influence of local delivery of bisphosphonate on osseointegration of dental implants: question: what is the influence of the local delivery of bisphosphonates on the osseointegration of titanium implants in humans? Evid Based Dent. (2018) 19:82–3

20. Ashraf M, George J, Sha II. Micro-Core decompression combined with intralesional zoledronic acid as a treatment of osteonecrosis of femoral head: A novel technique. J Orthop Traumatol Rehabil 2021;13:21-5.

21. Haenisch H. Arthritis dissecans der hufte. Zentralblatt Chir. 1925;52:999.

22. Ficat RP. Idiopathic bone necrosis of the femoral head. Early diagnosis and treatment. J Bone Joint Surg Br. 1985;67:3-9.

23. Mont MA, Hungerford DS. Non traumatic avascular necrosis of the femoral head. J Bone Joint Surg Am 1995;77:459 74.

24. Mohanty SP, Singh KA, Kundangar R, Shankar V. Management of non traumatic avascular necrosis of the femoral head a comparative analysis of the outcome of multiple small diameter drilling and core decompression with fibular grafting. Musculoskelet Surg 2017;101:59 66.

25. Agarwala S, Shah SB. Ten year followup of avascular necrosis of femoral head treated with alendronate for 3 years. J Arthroplasty 2011;26:1128 34.

EVALUATION OF HIP PAIN IN YOUNG PATIENT

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Determining the cause of a painful hip in a young adult can be a major challenge to the orthopaedic surgeons. Failure to diagnose and appropriately investigate pathologies of the hip in young adults may result in delayed management and prolonged patient morbidity. A systematic approach to investigating the aetiology of hip pain (history, clinical and radiographic examination) will help identify the majority of clinically important pathologies which can cause hip pain. A wide number of disorders including pathologies outside the hip can cause and refer pain to the hip.

The causes of hip pain in young adults has received less attention than those in children and older patients. As these patients present with symptoms originating from different disease processes, lack of awareness among treating orthopaedic surgeons may result in delayed diagnosis. There has been an evolution in the field's understanding of hip pain in young adults and it is now known that common causes like femoroacetabular impingement (FAI) and dysplasia can be diagnosed early and treated accordingly.

Femoroacetabular impingement is characterized by an early and pathologic contact during hip joint motion between skeletal prominence of the acetabulum and the femur. It is a dynamic pathological mechanism which comes from a limitation of the range of movements. Depending on the morphological alteration, we may distinguish two kinds of impingement. The first is the Pincer type where there is an abnormal acetabular morphology with a focal or general overcoverage of the femoral head. In this type of impingement, the initial damage is labral and involves the circumferential cartilage, while afterwards, due to the posterior subluxation, the chondral damage affects the posterior part of the acetabulum and of the femoral head. The second type of impingement is called Cam which is due to a lack of sphericity in the femoral head neck junction with decreased head neck offset. The contact of the aspherical head neck junction with the acetabulum leads to an abrasion of the acetabular cartilage or its avulsion from the subcondral bone, a process which is usually localized in the anterosuperior portion of the acetabulum.

Hip dysplasia is characterized by an ill oriented acetabular articular surface with loss of coverage (anterior or global) of femoral head. The consequently reduced contact area leads to an excessive and eccentric acetabular load with the development of early degenerative chondral alterations.

Dysplasia is often treated in childhood and so its incidence has been drastically reduced nowadays. Yet it remains crucial to identify the cases of mild dysplasia which may still be found in our population.

Symptoms

Pain is the most common presenting symptom of hip pain in adults, although this pain is most commonly located in the groin, it may also occur anywhere around the hip, thigh or be referred to the knee via the obturator nerve. Patients with intra articular hip pathologies cup the trochanter making a C sign (Figure 1). Trochanteric pain may be a result of bursitis or iliotibial band syndrome while adductor pathologies result in medial thigh pain. Spinal causes have to be ruled out if pain is predominantly in the buttock and burning pain results from neural causes.

Fig. 1 Illustration demonstrating C sign

Hip pain exacerbated by sitting for a prolonged period of time indicates impingement. Snapping or locking can be caused by labral tears, loose bodies or rubbing tendons. History of childhood diseases may suggest possible sequelae of Perthes or slipped capital femoral epiphysis (SCFE). Risk factors for avascular necrosis need to be screened during history. Participation in specific sports and recreational activities may also be important risk factors. For instance, labral tears are seen in footballers, runners often present with iliotibial band syndrome and cyclists may experience piriformis syndrome.

Clinical Examination

Adult patients with hip pain typically have an antalgic gait, abductor weakness can result in a trendelenburg gait. Change in foot progression angle results from femoral anteversion anomalies. Hip examination is done standing and then supine following the usual routine look, feel and move.

A patient can be screened for intra articular pathologies using a Stinchfield (resisted hip flexion), log roll or heel strike (hit on the heel with palm) tests. Flexion, abduction and external rotation (FABER test) can diagnose sacroilitis or posterior impingement depending on the site of induced pain. Ober test is effective at diagnosing tightness in the iliotibial band and the Thomas test is positive in those with tight iliopsoas tendon.

Intra articular Pathologies

Labral tears most commonly the result of acetabular dysplasia or FAI can cause pain and snapping around the hip. Synovial chondromatosis and pigmented villonodular synovitis are some examples of synovial pathologies. Capsular tears and laxity, chondral defects and ligamentum teres pathologies are other intra articular soft tissue causes of hip pain.

Sequelae of childhood diseases (Perthes & SCFE), septic arthritis, transient osteoporosis, osteonecrosis, and osteoarthritis are other bone related causes of hip pain in addition to FAI and dysplasia.

Radiological evaluation

Standard conventional radiographic imaging in evaluating the alterations in the shape of the hip joint is not only a primary role, but also cost effective and of rapid execution.

It represents the first step after clinical examination, while CT and MRI scans are second stage exams as they are useful for a more accurate morphological definition of the deformity.

Standard radiographic technique includes two radiographs, an anteroposterior pelvic view and an axial cross-table view. Correct positioning of the patient and an accurate radiographic technique are crucial for an accurate result.

For the anteroposterior pelvic view, the patient is in supine position with the legs 15A° internally rotated & the central beam is directed to the midpoint between a line connecting anterosuperior iliac spines and the superior border of the symphysis.

The axial cross table view is obtained by placing the leg internally rotated and with the central beam directed to the inguinal fold. An alternative to the axial view is a Dunn view in $45^0$of flexion.

Some of the common parameters checked below :

Lateral center edge angle : The angle formed by a line parallel to the longitudinal pelvic axis and a line connecting the center of the femoral head with the lateral edge of the acetabular sourcil. (Figure 2)

Fig. 2 Lateral central edge angle

Dysplasia < 22^0, Normal 23^0-33^0, Overcoverage (FAI) 34^0-39^0, Severe overcoverage > 40^0.

Acetabular Inde x: Angle formed by a horizontal line and a line through the most medial point of the sclerotic zone of the acetabular roof and the lateral edge of the acetabulum. (Figure 3)

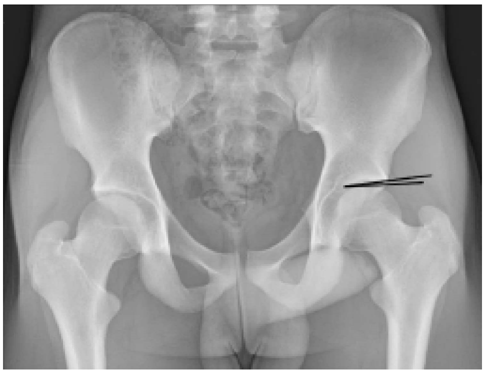

Fig. 3 Acetabular Index

Dysplasia > 14^0, Normal 3^0-13^0, Overcoverage (FAI) -7^0 to 2^0, Severe overcoverage < -8^0.

Extrusion Index: Percentage of uncovered femoral head in comparison to the horizontal head diameter.

Dysplasia > 27^0, Normal 17^0-27^0, Overcoverage (FAI) 12^0-16^0, Severe overcoverage < 11^0.

Sharp Angle: Angle formed by horizontal line and a line through the caudal tip of the teardrop and the lateral edge of the acetabulum. (Figure 4)

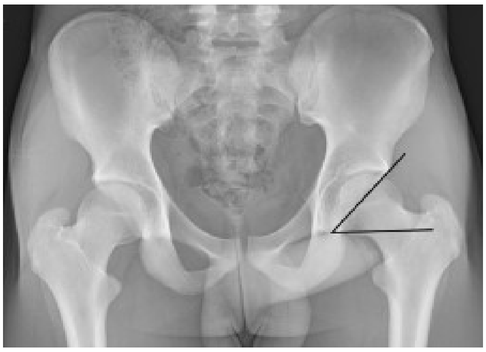

Fig. 4 Sharp angle

Dysplasia > 43^0, Normal 38^0-42^0, Overcoverage (FAI) 34^0- 37^0, Severe overcoverage < 34^0.

Crossover sign: Positive if the projected anterior wall crosses the posterior wall. (Figure 5)

Fig. 5 Cross over sign

Dysplasia > 14^0, Normal 3^0-13^0, Overcoverage (FAI) -7^0 to 2^0, severe overcoverage < -8^0.

Posterior coverage: The percentage of femoral head covered by the posterior acetabular rim in posteroanterior direction.

Dysplasia < 35^0, normal 36-47^0, overcoverage (FAI) 48-55^0, severe overcoverage > 56^0.

Anterior coverage: The percentage of femoral head covered by the anterior acetabular rim in anteroposterior direction.

Dysplasia < 14^0, normal 15-26^0, Overcoverage (FAI) 27-32^0, Severe overcoverage > 33^0.

Protrusio acetabuli: The femoral head is overlapping the ilioischial line medially.

Prominence of ischial spine: In clinical practice, when a cross over sign is seen, the ischial spine also is seen as a prominence in the pelvic cavity. There is a high correlation between the cross over sign and the prominence of ischial spine, that is easily visible on the AP radiograph as a projection in the pelvic cavity making it a reliable radiographic landmark for retroversion. (Figure 6)

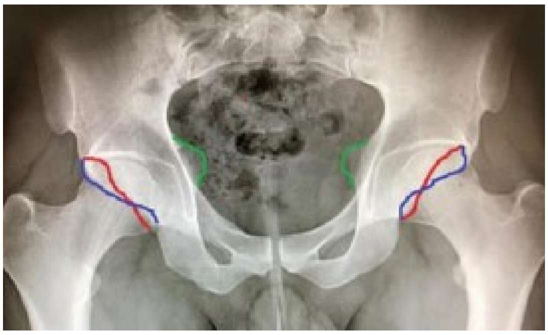

Fig. 6 Cross over & Ischial spine sign

Angle α : The angle between the femoral neck axis and a line connecting the head center with the point of beginning asphericity of head neck contour. It is useful to quantify the amount of asphericity of femoral head. An angle exceeding 50^0 is an indicator of an abnormal shape. (Figure 7)

Fig. 7 Angle α

Shenton line: Is an imaginary curved line drawn along the inferior border of the superior pubic ramus (superior border of the obturator foramen) and along the inferomedial border of the femoral neck. This line should be continuous and smooth.

Ultrasound is a user dependent investigation modality is helpful in diagnosing tendinitis and bursitis. This approach may also help to demonstrate real time fascial or tendon snapping.

Magnetic resonance imaging (MRI) aids in the diagnosis of osteonecrosis, labral & chondral lesions, infections, stress fractures and neoplasms. Intra articular pathologies are better seen in magnetic resonance (MR) arthrography.

Computed tomography (CT) scan is used to define osseous anatomy, acetabular version and impingement. CT arthrography can also be used to assess cartilage and labral tears, however its use is limited due to increased exposure to radiation.

Electromyography and Nerve conduction studies help in differentiating compression neuropathies from other causes of hip pain.

Conclusion

Recognition of conditions like FAI and dysplasia in their early stages, i.e. before the degenerative process is advanced and its early treatment is likely to have a considerable impact on the natural history of the disease, delaying the onset of end stage arthritis in these young patients.

INTERTROCHANTERIC VALGUS OSTEOTOMY

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Introduction :

An intertrochanteric osteotomy can help in treatment of many conditions of proximal femur by changing the direction of loading on the hip joint. Careful preoperative plan is made and proper execution of procedure without any mishaps during surgery plays an important role to achieve good results. The indications may vary, ranging from very good results in neglected cases of fracture neck femur(non union) , avascular necrosis involving a small well-circumscribed area , congenital coxavara, malunions of fractures in the trochanteric region. Prognosis can be significantly changed in other conditions like fresh femoral neck fractures in osteoporotic patients, intertrochanteric fractures with severe comminution of the medial buttress and osteoarthritis with a medial capital drop osteophyte.

How it works :

An intertrochanteric osteotomy activates a reparative process by hyperemia , increase in the rate of bone remodeling and by decreasing the magnitude of shearing forces in fractures. It protects the joint by increase in weight bearing surface area and decreasing compressive forces on the joint in osteoarthritis

Role of valgus osteotomy in non union of intracapsular femoral neck fracture :

Treatment of nonunion in intracapsular neck fracture in younger individuals is techniqually challenging in achieving good results with head preservation due to high shearing forces leading to displacement of fracture. If we change the inclination of the fracture it will decrease the shearing forces at the fracture site and converts them into compressive forces. This results in decrease of micromotion at fracture site, increases mineralisation of fibrocartilage, angiogenesis and endochondral ossification.This repositioning osteotomy results in stability and helps in union.

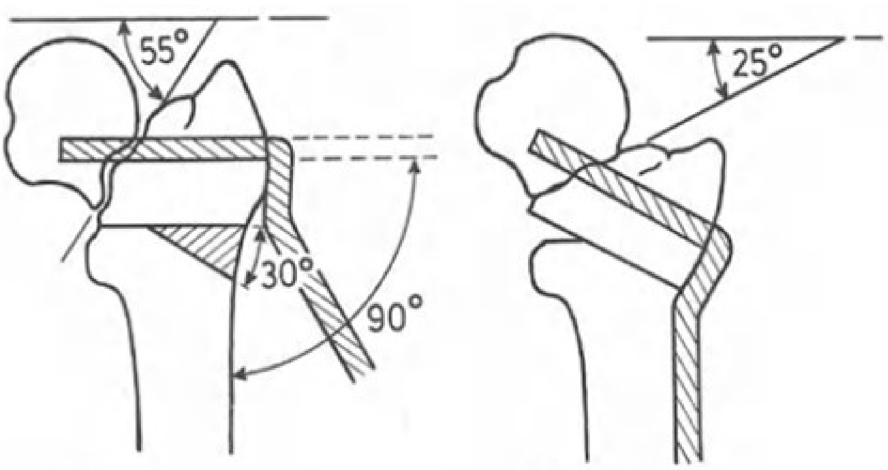
Prerequisites for osteotomy :

Viable femoral head is the main prerequisite, which is confirmed with radiographs and MRI. Similar bone density of the greater trochanter and of the femoral head and reactive sclerosis adjacent to the fracture site suggests strongly for viability in radiographs.

How to determine angle of wedge :

In a normal hip the resultant R of compressive forces sub tends an angle of 16° with a sagittal or body axis. The angle between the sagittal body axis and the anatomical axis of the femoral shaft is 8°-10°. Thus, a fracture line which sub tends an angle of 25° with the perpendicular to the femoral shaft axis is placed under pure compression by converting shear forces to pure compressive forces **(Pauwels et al)**

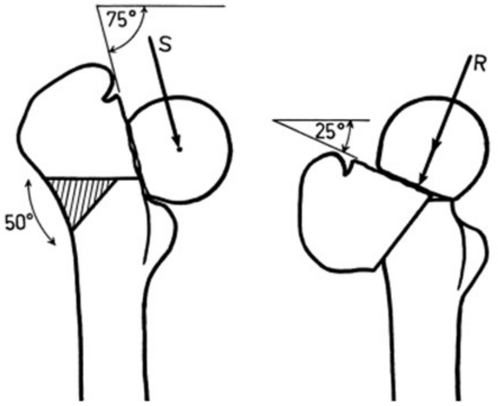
The angle of correction is determined by substracting 25° from the angle which the fracture line sub tends with a perpendicular drop to the femoral shaft axis.



For example: If Pauwels angle is 55 degrees we have to remove 30 degree wedge

Angle of wedge = Pauwels angle(Fracture line) --- 25°

Routinely we do **simple lateral closed wedge osteotomy**, but if the head had slipped down, we have to do **Y osteotomy** which allows to medialize the shaft and support the femoral head. The disadvantage of this is limb shortening and genu valgum.



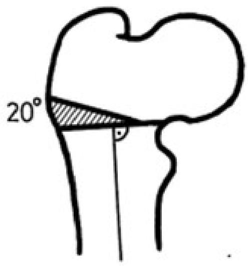
S : Shearing force

R : Resultant R of compresive force

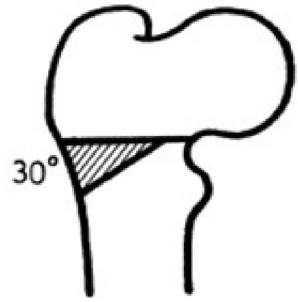
Planning of osteotomy cuts :

First osteotomy cut at right angles to the femoral shaft axis at the level of lesser trochanter(superior border)

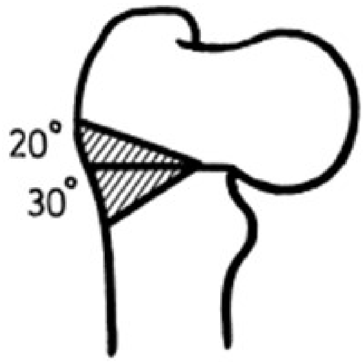
Second osteotomy cut depends on the wedge of the bone to be removed. If less than 25 degree wedge to be removed take it from proximal fragment only, by passing K-wire at desired angle to the first cut in the proximl fragment.



If 20 degree wedge to be removed, remove it from Proximal fragment



If 30 degree wedge to be removed, remove it from distal fragment



If more than 30 degree removal needed, remove 30° wedge from the distal fragment and the remaining wedge from the proximal fragment

Technical details of osteotomy :

Pre operative radiograghic confirmation of viability of femoral head and measurement of Pauwels angle(AP view of the hip in traction and internal rotation) and to have the idea for amount of wedge .

Planning of osteotomy cuts as described previously

Before going to osteotomy, Insertion of guide wire for implant should be done.

First insert guide wire in superior part of neck and replace with 6.5 mm CC screw to achieve compression at the non union site. If not done chances of displacement at fracture site can occur.

Lag screw guide wire placed aiming at inferiomedial quadrant of femoral head

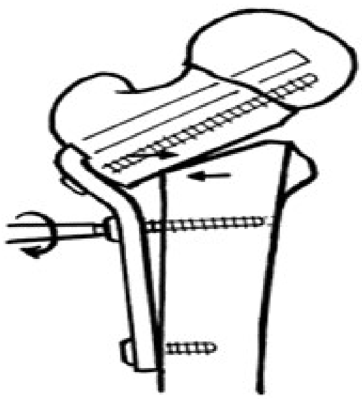
Angle of insertion of guide wire depends on amount of wedge to be removed

Angle of insertion guide wire = Plate angle – angle of wedge to be removed

Fixation of the Intertrochanteric Osteotomy

Blade plate, double angled DCS or DHS can be used. Blade plate is superior in results because of its inherent rotational stability.

After removal of wedge, abduct the limb to reach the plate and fix with cortical screws from distal to proximal. If the most distal screw is placed in before the plate touches the proximal part of the femoral shaft (a distance of about 0.5-1.0 cm), the insertion of the proximal screws will then produce interfragmental compression(Muller et al).



In lateralizing the shaft, the minimal permissible contact area between the osteotomy surfaces is one-third of the diameter of the shaft should be maintained

Keep the wedge removed as bone graft between the plate and bone at the osteotomy site.

Complications of osteotomy

Avascular necrosis as a result of injury to the posterior retinacular vessels.

Loss of position of the fragment can

happen if the implant cuts out of the proximal fragment or if there is insufficient contact of bone medially.

If the ridge of bone between the osteotomy and the blade or lag screw of the plate is too thin (it should be atleast 2 to 2.5 cm) loosening of lag screw or the bridge may actually break leading to loss of fixation

If displacement occurs due to any of the above factors, still revision osteotomy has a role if proper principles of osteotomy and fixation are followed.

Operative technique :

- Patient in supine position on fracture table
- Incision of ten centimetres given from tip of trochanter to distal shaft of femur through the lateral approach.
- In non union cases 2.5mm k wire is passed to stabilze the non-union site and fixed with 6.5mm cannulated cancellous screws to prevent head rotation.
- Standard guide wire entry point with angle guide of desired calculated angle is used to pass a guide wire to inferior quadrant of head. (in case of old fixation care is taken in such a way to avoid old screw tracks).
- DHS is used due to techinical simiplcity and avaliability.
- Guide wire reaming and lag screws placement is done under c arm guidance
- K wires are passed under c arm guidance both proximally and distally for osteotomy of desired wedge.
- Osteotomy is completed under c arm guidance with bone saw (Tip: not to cut the medial cortex with bone saw. Medial cortex is drilled multiple times with k wire).
- Limb is brought to abduction near to barrel plate and fixed with screws.
- Skin closed in layers.

Case scenario :

- 45 years female patient presented to us with 3 weeks old intra capsular fracture neck of right femur.Traction with internal rotation radiographs revealed 55 degrees of Pauwels angle (Fig 1). Plan was made to decrease the angle to 25 degrees.Entry point for guide pin was assessed after substracting 30 degree from Pauwels angle which was measured pre operatively.Through lateral approach guide wire for lag srew was passed in 100 degree with angle guide. After reaming, dynamic hip lag screw was passed into desired position. Followed by, K wire placement for osteotmy to achieve 30 degrees of wedge (Fig2). After completion of osteotomy(Fig 3),limb was abducted and fixed with 130 degrees barrel plate with cortical screws as described above(Fig4). Removed wedge kept as graft at the angle of plate. Post-operative weight bearing was defered until attempt of bone healing.Patient was advised regular hip/knee physiotherapy.

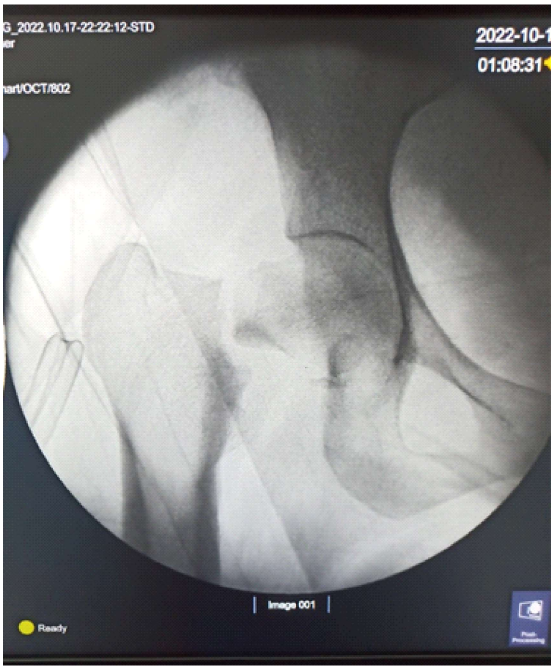


Fig 1: Pre opertive radio graph

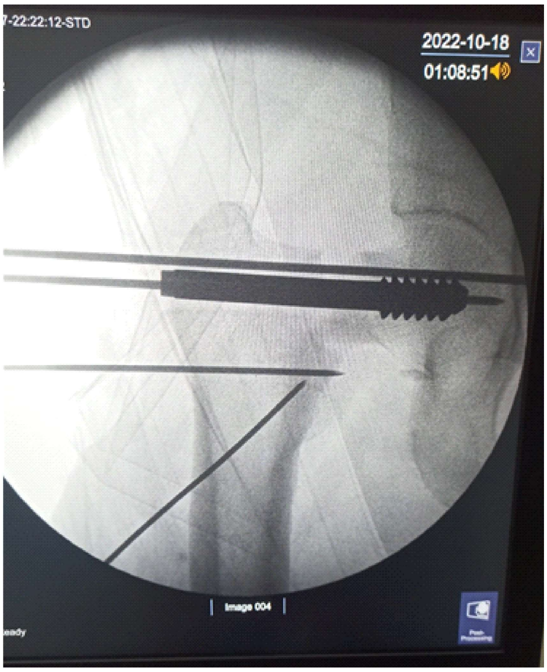


Fig 2: Image showing guide wire for lag srew and osteotomy k- wires

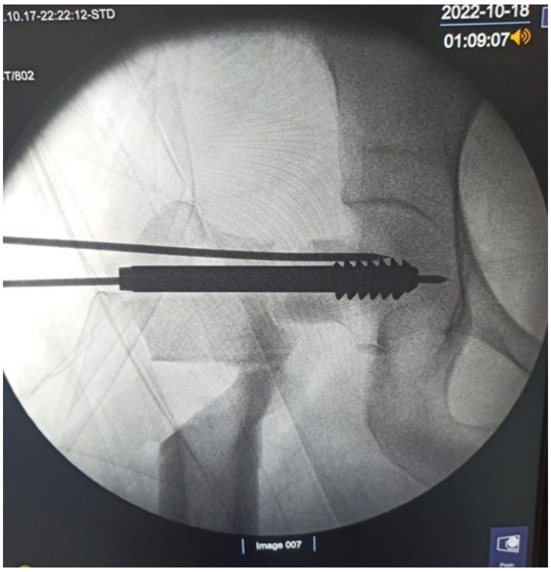


Fig3: Removal of wedge

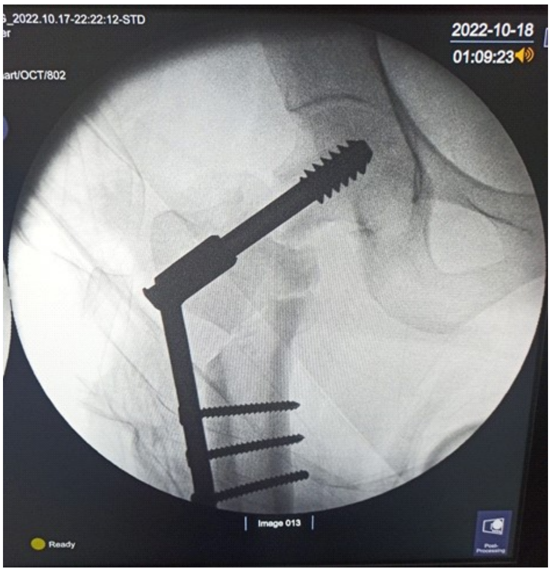


Fig4: Image showing fixation with DHS after osteotomy

Analysis of our results :

In our experience of 17 cases of valgus osteotomy for nonunion of femoral neck fractures , we were able to achieve union in fifteen patients . In one case avascular necrosis was seen which was treated accordingly . Limb length equalisation was achieved in 14 patients with average neck shaft angle of 137 degrees(range of 130-145degrees).Average harris hip score of 91 points (range 76-94 points) with 80 percent of excellent results at three years follow up.

Conculsion:

Valgus inter tronchanteric osteotomy is the treatment of choice in non union neck fractures for head preservation in less than 60 years of age. This technique requires meticulous pre operative analysis and careful execution of procedure. Patient should be counselled for complications related to the procedure.

References :

Pauwels F (1976a) Biomechanics of the normal and diseased hip. Theoretical foundation, technique and results of treatment. Springer, Berlin Heidelberg New

York Muller ME (1975) Intertrochanteric osteotomies in adults: planning and operating technique

HIP ARTHROSCOPY

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Hip arthroscopy has been gaining popularity since the last two decades. Hip arthroscopy was initially limited by the unique anatomy of the hip joint which presented challenges due to the constrained bony anatomy, thick soft tissue envelope and proximity of the neurovascular structures. Arthroscopy instruments used in the knee and the shoulder were not routinely capable of handling the depth of the hip joint. However, the development of hip specific arthroscopic instruments and improved techniques for exposure has resulted in greater accessibility to the joint. **(Figure 1)**

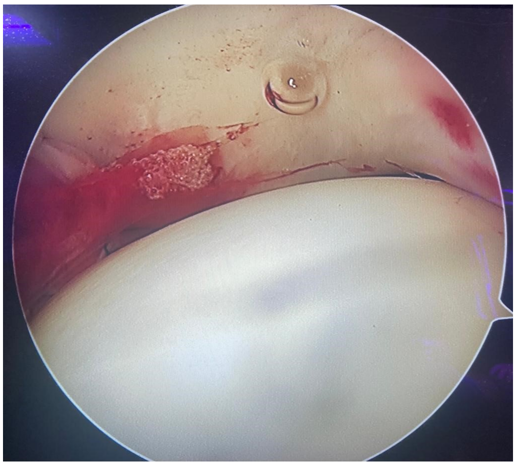

Fig : 1 View inside the hip joint (Femoral head below, Labrum & capsule above)

Current indications for hip arthroscopy can be divided into four pathologies: the central, peripheral, peritrochanteric and subgluteal compartments.

The pathologies in the central compartment for which hip arthroscopy can be useful include labral tears, chondral pathology, septic arthritis, loose bodies & avascular necrosis of the femoral head.

The pathologies in the peripheral compartment for which hip arthroscopy can be useful include femoro acetabular impingement, capsular & psoas tendon disorders.

The pathologies in the peritrochanteric compartment for which hip arthroscopy can be useful include trochanteric pain syndrome & iliotibial band disorders.

The pathologies in the deep gluteal space for which hip arthroscopy can be useful include ischiofemoral impingement, proximal hamstring & sciatic nerve disorders.

Femoroacetabular Impingement (FAI)

FAI is a disorder that results from abnormal contact between the femoral head neck junction and acetabulum that can lead to labral and chondral pathology. Cam type FAI occurs when there is an abutment of the femoral neck against the acetabulum due to a morphological abnormality of the femoral head and neck junction, whereas pincer impingement occurs when an abnormal excess growth of the acetabular margin leads to impingement against the femoral neck, with both types leading to damage of the articular cartilage and labrum of the hip joint. **(Figure 2)**

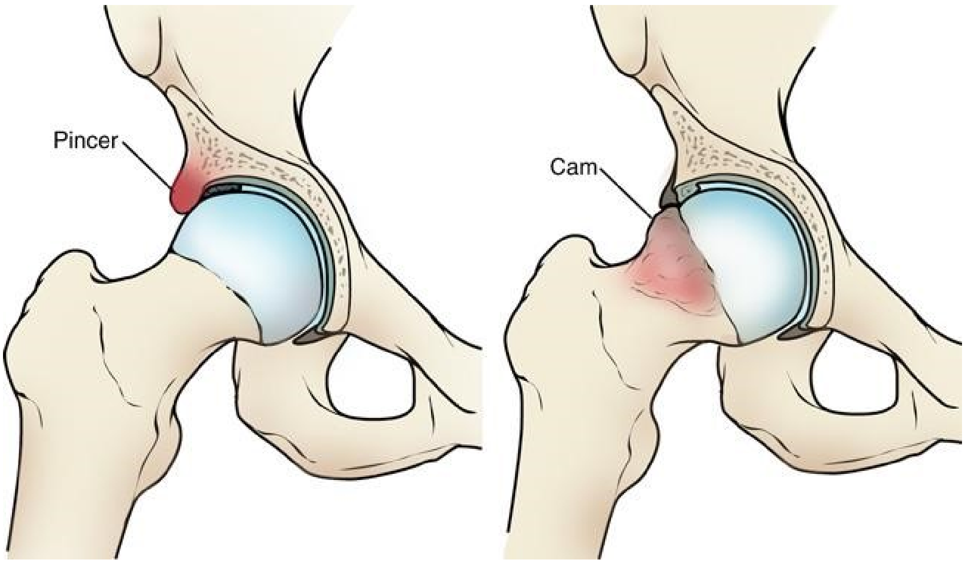

Fig : 2 Line diagram representing the cam and pincer lesions (Reproduced from the open access article – Strosberg DS et al. The Role of Femoroacetabular Impingement in Core Muscle Injury/ Athletic Pubalgia: Diagnosis and Management. Frontiers in Surgery 2016 3(6):1-5

The recognition of femoroacetabular impingement as a source of hip pain in young adults has also expanded the indications of hip arthroscopy by applying the principles of osseous correction which were previously operated by open surgical dislocation. Although hip arthroscopy is a minimally invasive procedure that may offer decreased morbidity, diminished risk of neurovascular injury and shorter recovery periods compared with traditional open exposures to the hip, it is important to understand the appropriate patient selection and indications to optimise patient outcomes and minimise complications.

Diagnosis of FAI :

The patient usually presents with hip pain exacerbated by hip flexion. Mechanical symptoms of hip clicking or popping may be present if there are associated labral tears. A thorough exam of the hip should be performed in every patient including a gait evaluation and then specific hip tests noting the range of motion, both passive and active. If pain occurs during active motion, the pain may be related to a tendon or muscle injury and then the location of the pain may give a clue as to the source of the injury. Passive motion testing partially negates the muscular component and could give more information about mechanical issues such as impingement. A positive anterior impingement sign is marked by pain with hip flexion at 90 degrees, adduction and internal rotation **(Figure 3)**.

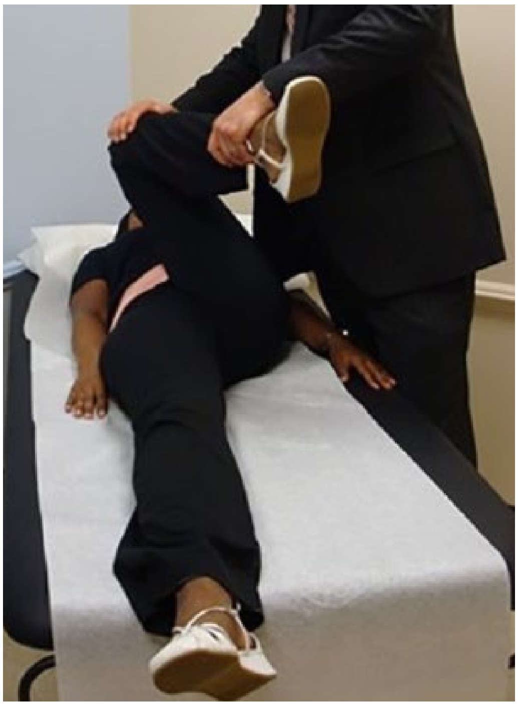

Fig : 3 Picture demonstrating the anterior impingement test on the patient

If there is no evidence of impingement on physical exam, then the diagnosis of FAI should be questioned and further investigations performed to find the true source of the hip pain.

The differential diagnosis for FAI can be divided into other intra articular sources of hip pain, extra articular hip pain and referred pain from the back or sacroiliac joints. These include stress fractures of the femoral head or neck, osteitis pubis, adductor tendon injuries, iliopsoas tendon problems, piriformis syndrome, gluteus medius or minimus tendonitis, greater trochanteric bursitis and radiculopathy.

The basic radiographs to obtain are an anteroposterior(AP) Pelvis, Dunn lateral & cross table lateral views. It is important to ensure that the radiographs are adequately performed, as alterations in pelvic tilt or radiograph angle could give the impression of over coverage. CT is helpful in better defining the cam and pincer lesions. MRI is more accurate in diagnosing labral and cartilage pathology when combined with an intra articular gadolinium injection.

Treatment of FAI :

Conservative management of FAI is usually attempted first and this includes activity modification and avoidance of certain positions as well as hip stabilisation and strengthening exercises. If conservative treatment fails, it can be resolved surgically. Its sequelae, such as labral tears and chondral damage can also be repaired to a certain extent. Historically, an open approach to the hip with dislocation was used to correct the bony deformity and repair any labral or cartilaginous damage. Over the last two decades, hip arthroscopy has been successfully used as a less invasive treatment option.

The procedure Patient Positioning :

Patient positioning can be either in lateral decubitus or supine, yet the supine position is the most commonly used due to better orientation and the ease of access.

The layout of the operating room, patient positioning and set up are extremely important in ensuring that the procedure goes smoothly and these are an integral part of the planning.

The patient's lower extremities must be well padded and secured to the boots. The operated leg should be placed in traction around a well padded post and care is taken to protect the perineum. The hip is slightly flexed to relax the capsule. The C arm is positioned in a way to obtain an image that matches the hip on the AP pelvis radiograph.

Identify and Mark Landmarks :

Once the traction is applied to open the hip joint space, mark the tip of the greater trochanter along with the anterior and posterior aspects. Also mark the anterior superior iliac spine and draw a vertical line straight down the thigh from there. This will avoid injury to the femoral neurovascular bundle which lies medial to this line. Draw a line perpendicular to this line from the tip of greater trochanter.

Establish Anterolateral and Mid Anterior Portals (Figure 4) :

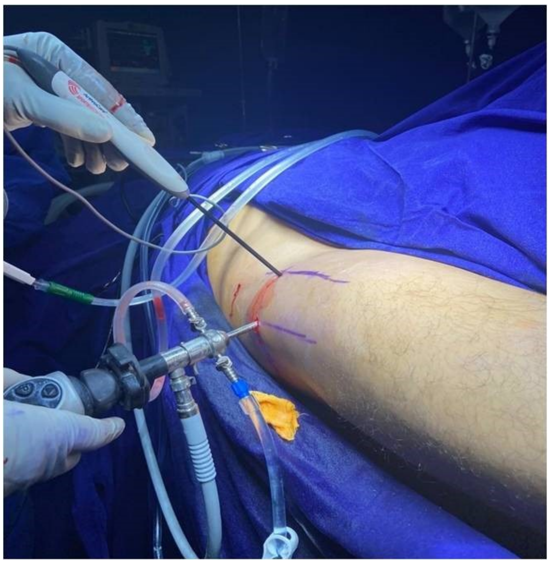

Fig : 4 Picture showing the anterolateral and mid anterior portals during hip arthroscopy

Adequate portal placement is key for visualization and instrumentation. There are many described portals and all are within a safe zone lateral to a vertical line drawn down the anterior aspect of the thigh from the tip of the anterior superior iliac spine. The most commonly used portals are anterolateral and mid anterior portals. The anterolateral portal is the first one to be achieved and is located about 2 cm anterior and 2 cm superior to the anterosuperior border of the greater trochanter. The position of the anterior portal is slightly inferior and lateral to the intersection of the lines coming from the anterior superior iliac spine and the perpendicular line coming from the tip of greater trochanter. There are multiple additional portals that can be used depending on the procedure that needs to be performed.

We use a 17 gauge spinal needle to place the anterolateral portal. We place the needle about two thirds away from the acetabulum and one third from the femoral head. Once resistance is felt, the capsule is pierced. We confirm the position with C arm. We remove the stylet and inject about 20 ml of normal saline solution to create separation between the labrum and capsule. Backflow of fluid at this point confirms that the needle is intra articular. We insert a Nitinol wire through the spinal needle and direct it towards the cotyloid fossa confirming with the C arm **(Figure 5)**.

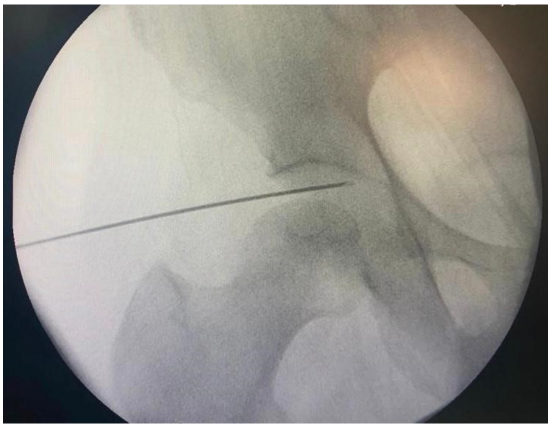

Fig : 5 Nitinol wire inside the hip joint

We make a small incision on either side of the Nitinol wire with a size 11 blade and make sure that there are no skin bridges. We then place the Wissinger arthroscopy switching rod followed by the cannula in the same fashion **(Figure 6)**.

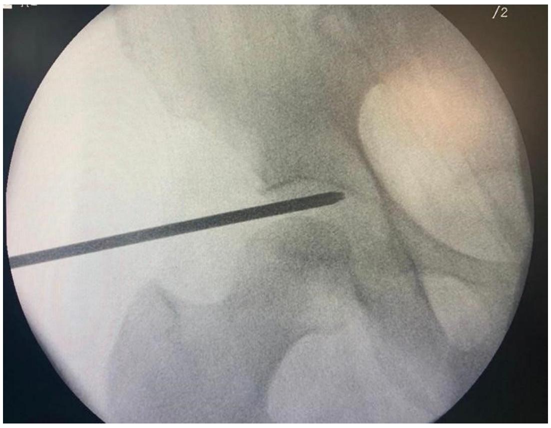

Fig : 6 Wissinger switching rod inside the hip joint

We need to take extreme care to make sure Nitinol wire is not bent or broken while introducing the Wissinger rod. We remove the handle of the cannula and introduce the 70° view arthroscopic camera. We do not start the irrigation fluid inflow at this point until a second portal is established. We perform a dry scope and view the hip joint both posteriorly and anteriorly to assess the femoral head, acetabulum, labrum, and chondrolabral junction.

We then establish the mid anterior portal as per the marking done before. We use a 17 gauge spinal needle to place the portal under direct visualization and at an insertion angle of about 30° cephalad and posterior. The needle should enter the joint in the middle of the intra articular triangle made up of the femoral head, labrum and the capsule. At this point, inflow can be turned on. We can move the camera to the anterior portal. Viewing laterally, we can confirm that the anterolateral portal is not through the labrum. We can inspect the rest of the joint.

Capsulotomy and Central Compartment Assessment :

We perform a capsulotomy with an arthroscopic knife or radio frequency device in order to facilitate visualization and navigation within the joint and in the peripheral compartment. Closure of the capsulotomy is a matter of debate although most surgeons tend to repair large capsulotomies for the fear of post operative instability.

We can visualize the anterior acetabular wall followed by the posterior acetabular wall. We can assess the ligamentum teres by internal and external rotation of the foot under mild traction. We can inspect and probe the anterior-superior acetabular chondrolabral junction for fraying and tears.

Acetabuloplasty :

We can elevate the capsule and labrum from the acetabulum to access and shape the acetabular rim. We can use electrocautery & shaver to separate the capsule from the acetabulum/ labrum. We can then use a 5.5-mm burr for correction of acetabular over coverage. We need to perform this under C arm guidance. Accurate pre op planning is essential to avoid over or under correction.

Focal chondral defects in the acetabulum or on the femoral head can then be addressed with chondroplasty, microfracture, bone marrow aspirate concentrate & Tisseel glue injection depending on the availability and the size of the defect.

Labral repair :

Repair of the labrum should be performed if the tissue is viable as labral preservation is one of the primary goals of hip arthroscopy. The labrum is brought back to a bleeding bony edge with the help of anchors. Careful placement of these anchors is critical in order to avoid chondral injury. The repair can be performed around the labrum or through the base of the labrum using a vertical mattress configuration if there is enough tissue available. This preserves the anatomy of the labrum and gives the best results biomechanically restoring the suction seal. When the tissue is beyond repair, labral debridement or reconstruction can be performed depending on the case. Labral reconstructions have been performed using multiple types of grafts such as the gracilis tendon, the iliotibial band or the head of the rectus femoris as a local graft.

Peripheral Compartment Assessment and Femoroplasty :

As with the acetabuloplasty, the femoroplasty requires accurate pre operative planning with regards to the exact location of the excess bone and the amount of reshaping. This part of the procedure is performed with the leg out of traction. It will need to be flexed and extended and rotated so the entire head neck junction can be visualized. The C arm position is very important in this step as well. We must try to place the C arm so that the image on the screen is as close as possible to the image on which the pre operative planning was performed. The leg and C arm may need to be rotated in order to ensure adequate and no over resection. This is the part of the procedure where the capsule may obstruct the view and may need to be further opened depending on the technique chosen. Some surgeons mark the area to be resected with a curette or cautery before using the burr to reshape the femoral head neck junction. As FAI is a dynamic condition, an important part of assessing the adequacy of the bony work is putting the leg through a range of motion to ensure that the impingement has been dealt with. During this dynamic evaluation, the labral repair, if one has been performed, can also be assessed. Thorough irrigation is important to decrease the debris and the chance of heterotopic ossification. At this point, a large capsulotomy if performed previously would be repaired and the procedure completed with portal closure.

Complications :

Most complications related to hip arthroscopy for FAI can be avoided by choosing the right patient and with careful planning, positioning and execution. Recent studies have shown that the complication rates are underestimated. Nerve injuries due to portal placement, traction and compression from positioning are the most common complications. These are usually temporary and can be prevented with adequate padding and by respecting traction time limits. Labral injury, cartilage scuffing and instrument breakage which are more common at the onset of the learning curve are also avoidable with the safe technique. Chondral damage can also occur due to poor anchor placement or careless instrument manipulation.

The most common reason for revision surgery is inadequate bony resection. This could be due to inadequate visualisation or planning and lack of experience. Under resection can be treated with revision surgery. Over resection, on the other hand, can lead to permanent damage to the joint and hip instability. Over resection of the cam lesion will lead to abnormal hip mechanics and can also cause fracture.

Results :

Meta analyses and systematic reviews have shown that the management of FAI via hip arthroscopy is successful and safe. A recent meta analysis of 29 clinical studies investigating almost 2,000 hips revealed a complication rate of 1.7% and a reoperation rate of 5.5%. In a recent systematic review, it was found that, when arthroscopic management was performed by an experienced surgeon, the outcomes were superior to those of other surgical approaches (open dislocation and mini-open). The major complications included femoral head neck fracture, loss of fixation requiring a reoperation, failure of labral fixation, inadequate osteo chondroplasty requiring surgical revision, infection, and symptomatic limitation of hip motion from heterotopic ossification.

Although the above results are encouraging, it should be cautioned that patient selection remains an important prerequisite for hip arthroscopy. Pre operative osteoarthritis with joint space narrowing have been associated with failure of hip arthroscopy for FAI. The ideal patient for arthroscopic treatment of FAI is a young non arthritic patient who is symptomatic and has clinical and radiologic evidence of focal impingement.

Recent studies have shown that the patients aged > 45 years tend to have poorer results than younger patients with a higher rate of conversion to total hip replacement. Multiple articles have been published citing a high rate of return to sports in athletes and excellent pain relief after arthroscopic surgery for FAI. Further research should have better levels of evidence and address a discrepancy in hip arthroscopy outcome reporting methods between what is suggested as important in the literature and what is actually being reported.

Conclusion :

In conclusion, hip arthroscopy for FAI can have excellent outcomes, as long as the indications are suitable and the surgeon has the required skills. In the wrong patient, and in the wrong hands, this can be a harmful surgery with severe complications, so each aspect of the surgery must be well planned and well executed. If this is a procedure you would like to perform, it is recommended that you take the time to learn it and practise it well under expert supervision before applying it to your patient population.

MEDIAL OPEN WEDGE OSTEOTOMY FOR OA KNEE

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INTRODUCTION

Osteoarthritis is the second most ubiquitous rheumatologic quandary and it is the most frequent joint disease with a prevalence of 22% to 39% in India[1]. OA is more communal in women than men and a major cause of mobility impairment. The prevalence increases dramatically with age. In the recent times incrementing number of patients with incapacitating knee pain are presenting for treatment in the 4th, 5th decade itself [1]. In these set of patients limb alignment has been cited to be one of the major contributor to early unicompartmental arthritis. Most of our patients have inherent varus deformity leading to medial compartment osteoarthritis[2]. Even in a limb with neutral alignment, the medial compartment conveys 55-70% of knee load during the stance phase of gait and in a varus deformity the loading forces further increase on the medial side. So, the medial compartment is more commonly affected than the lateral compartment. Not all patients with varus malalignment develop OA, but once the arthritis sets in the progression is rapid and further exaggerates the varus deformity secondary to cartilage wear and further overloading on the medial compartment. In most of these patients all it needs is realignment of the knee to off load the medial compartment.

Non surgical treatment options give reasonably good relief in early phase of osteoarthritis. As the disease advances to end stage medial compartment osteoarthritis (MCOA) surgical treatment options are inevitable [3]. There are different surgical options to address an arthritic knee.

1. High tibial osteotomy (HTO)
2. Unicompartmental knee arthroplasty (UKA)
3. Total knee arthroplasty (TKA).

It is a well-accepted fact that UKA & TKA are established procedures but there are concerns about the longevity of implants due to accelerated wear and early loosening, especially in younger & active patients. In a young and active patient if we are looking at a joint that should last for more than 30years we should start off with an Osteotomy and then gradually progress to an arthroplasty option when appropriate.

HTO is a good option in these set of patients with varus malalignment. It restores the mechanical axis and brings symptomatic relief in these patients by off-loading the degenerated medial compartment and by shifting the weight-bearing forces to the healthier lateral compartment[3].

One myth that has often been expressed about HTO is that the long-term results are poor. There are good studies which have reported survival rates of 85%-90% at 10 years. Most of the studies with good long-term outcomes have pointed that post-operative limb alignment is the most important predictor for good long-term outcomes. If the weight bearing axis passes through the Fujisawa joint and if we can get the HKA between 183^0 – 186^0 our long-term results are bound to be good.

INDICATIONS :

1. Isolated medial compartment osteoarthritis
2. Age less than 65 years
3. Varus deformity less than 20^0
4. Fixed flexion deformity less than 5^0
5. Stable knee with range of movement up to 100^0.

CONTRA-INDICATIONS :

1. Patients with bi and tri-compartmental osteoarthritis
2. Inflammatory arthritis of the knee
3. Knee with Ligament injuries (Would require ligament reconstruction along with HTO)
4. Age above 65 years
5. Morbidly obese patients
6. Flexion contracture more than 10^0.
7. knee flexion less than 90^0

Of the above age and obesity are only relative contraindications.

TYPES OF HIGH TIBIAL OSTEOTOMY :

HTO can be performed by various methods like –

1. Medial opening wedge HTO.

2. Lateral closing wedge HTO
3. Dome or barrel vault HTO.

DOME OR BARREL VAULT HTO :

Dome technique was initially used for High tibial osteotomy and it had its own advantages. This osteotomy doesn't remove any bone and no bone grafts are required. Large corrections can be done. However technically demanding procedure, disruption of tibio-fibular joint aggravating lateral or postero-lateral laxity[4] are common disadvantages which led to fall out of this technique over time.

LATERAL CLOSING WEDGE HTO :

The lateral closing wedge technique of HTO was a popular technique which was followed for quiet sometime. Reasonably good results were achieved with this technique. Changes in tibial slope, truncation of tibia are common challenges which surgeons faced in converting these HTO knees to TKR at a later date. There were also changes in patellar dynamics.

MEDIAL OPENING WEDGE OSTEOTOMY :

Medial opening wedge osteotomy became popular in view of the issues with the above techniques and with the advent of modern fixation techniques this technique of osteotomy started gaining popularity over the other methods[5] and is the current trend of HTO.

TYPES OF MEDIAL OPEN WEDGE HTO :

There are types of medial opening wedge high tibial osteotomy based on the fixation device

1. Uniplanar high tibial osteotomy which is commonly used with Monolateral fixator. (Figure 1).

Fig 1 : X ray showing uniplanar osteotomy with Monolateral External fixator.

2. Biplanar high tibial osteotomy which is commonly used with plating (TOMOFIX) Figure 2

Fig 2. X ray showing Biplanar osteotomy with plate fixation

FIXATION TECHNIQUES OF MEDIAL OPEN WEDGE HTO

There are different ways to fix an HTO. With the advent of new locking plates and fixators specifically designed for this procedure, we are able to achieve better fixation and aggressive early rehabilitation can be done following the procedure. Commonly used fixation options are –

1. Plate-and-screw fixation (Fig 2) with or without autogenous bone graft or bone graft substitutes.

2. Monolateral dynamic external fixator (Fig 1) or ilizarov fixator with the principle of gradual distraction by hemicallotasis (HC)

Irrespective of the type of osteotomy appropriate pre op planning is very important to achieve accurate post-operative alignment, which is the most important predictor of long term outcome of HTO[6-9].

PRE OP WORK UP :

1. Blood workup as per standard anaesthesia protocols
2. X ray of Knee – AP standing, Lateral in maximum extension (Figure 3)
3. Scanogram of both lower limbs in standing position. (Figure 4)
4. Valgus stress film to assess medial joint line Opening (Figure 5)
5. MRI of knee joint – to check for status of the ligaments & importantly to assess lateral cartilage condition.

Fig. 3 : X ray of knee – AP standing, Lateral in maximum extension

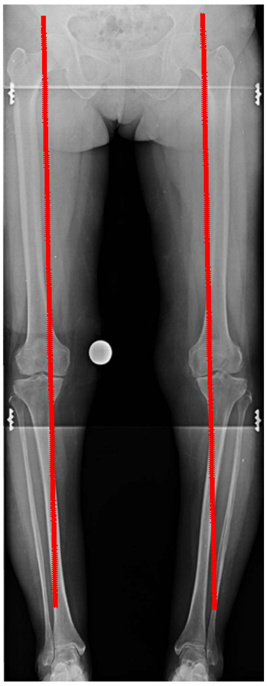

Fig. 4 : Scanogram of both lower limbs in standing position.

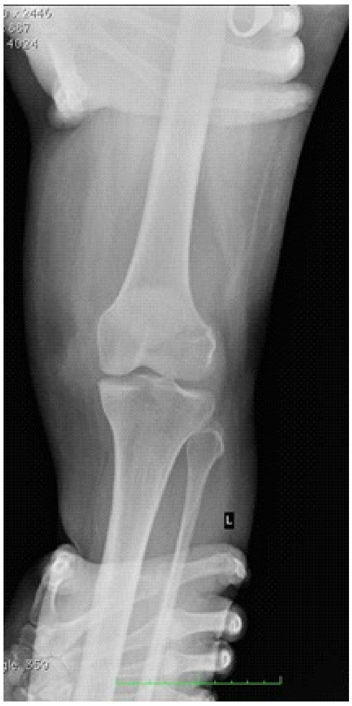

Fig. 5 : Valgus stress film

PRE-OP PLANNING :

1. Weight bearing scanogram of both lower limbs from hip joint to ankle joint is taken and MLDFA, MPTA are measured and CORA is determined. Most of the times the CORA is in the proximal tibia at the level of fibular head. It is important to note that the CORA can at times be in the distal femur and in these cases a distal femoral osteotomy would be more appropriate.

2. Detailed planning is described from Figure 6 – 9.

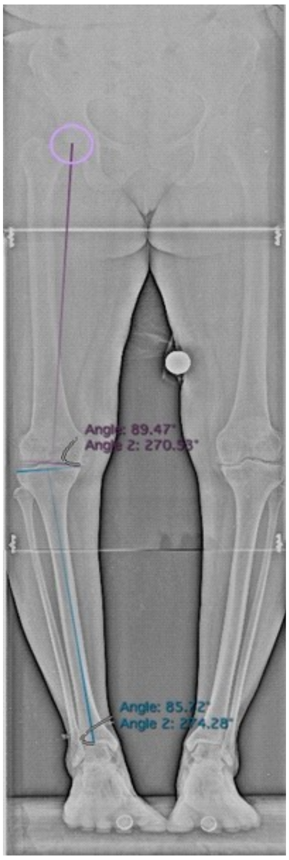

Fig. 6 Draw mLDFA - Mechanical lateral distal femoral angle (purple line) and MPTA – Mechanical medial proximal tibial angle (blue line).

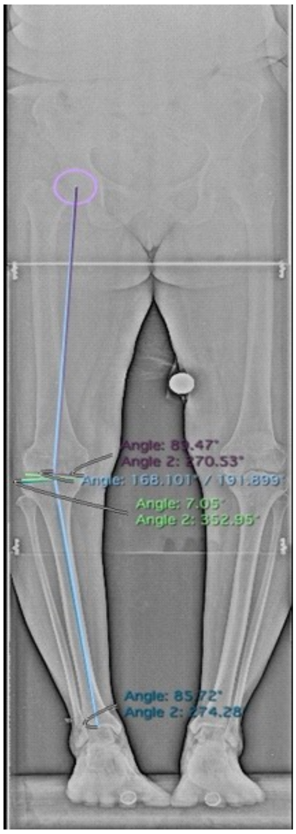

Fig. 7 Draw Hip-knee-ankle (HKA) angle from centre of hip joint to centre of knee joint and then to centre of ankle joint(blue line). Draw Joint line convergence angle (JLCA) corresponding to distal femur and proximal tibia condylar surfaces (green line).

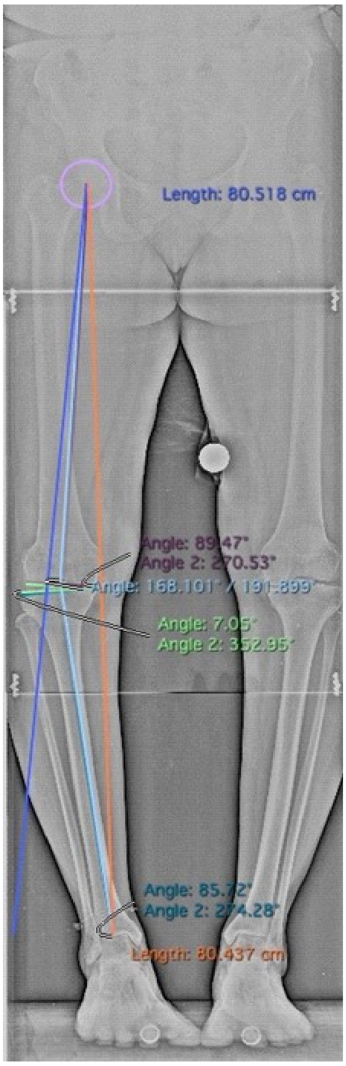

Fig. 8 : Draw current weight bearing axis of the limb (orange line) and desired weight bearing axis passing through Fujisawa point (dark blue line).

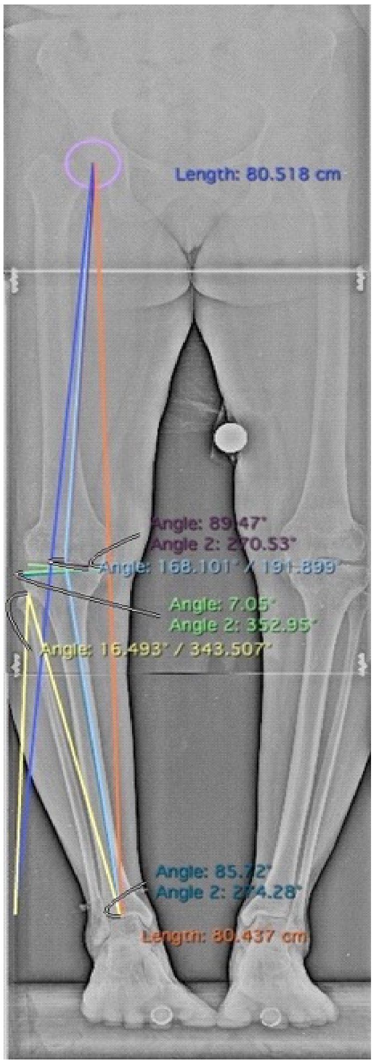

Fig. 9 : Measure the CORRECTION ANGLE which is between the current weight bearing axis and the desired weight bearing axis keeping the hinge at the level of fibular head which is us (yellow line).

DEGREE OF CORRECTION REQUIRED = CORRECTION ANGLE - JLCA

During correction we always have to remember that 1 degree of correction is not always equal to 1mm.

Fig. 10 : Lateral X ray of knee joint showing Insall salvati ratio calculation

Fig. 11 : Lateral X ray of knee joint showing Posterior tibial slope.

3. The Insall-Salvati index and tibial slope were estimated on lateral radiographs (Figure 10-11)

The aim is to make weight-bearing line pass from 62.5% from medial margin of tibia condyle which is Fujisawa point. In simple terms weight bearing axis passing through the lateral margin of the lateral tibial spine. We have to aim for a HKA axis to be 183-186 degrees.

SURGICAL PROCEDURE

Exposure & K wire placement to Mark osteotomy :

Surgery is performed under spinal anaesthesia in supine position with knee in full extension and patella centred over intercondylar notch. A 6–8 cm longitudinal skin incision is placed on the medial aspect of proximal tibia beginning one centimetre below the joint line and extending to the pes anserinus tendons. Two 2.5 mm Kirschner wires are placed into the tibia metaphysis under image intensification to mark the direction of the osteotomy. First posterior wire is placed at the cranial border of the pes-anserinus just in front of the posterior tibial ridge and the second wire is placed about 2 cm anterior and parallel to the first wire. Both wires must be parallel to each other to maintain the inclination of the tibial slope and the wires are aimed towards the level of fibular head which is the hinge point. The wires must overlap in Ap view under image intensification showing as one line. The wires must end at the lateral tibial cortex.. When placing the two wires, it is important to ensure that there is sufficient space for the four locking screws of TomoFix plate cranial to the osteotomy, leaving at least 30 mm of distance to the ridge of the medial tibial plateau.

Osteotomy :

Next step is to mark the cutting depth on the saw blade and perform the transverse osteotomy. The transverse osteotomy (Fig12a) can be performed with a drill bit & osteotome or with an oscillating saw below the two Kirschner wires that act as a guide. Be sure to complete the osteotomy cut of the hard posterolateral and posteromedial tibial cortex. Osteotomy is performed leaving the lateral cortex intact as hinge. Once transverse osteotomy is done anterior ascending saw cut(Fig 12b) is done according to the defined angle. (which usually runs at an angle of around 110° to the transverse saw) ending behind the patellar tendon. This tuberosity segment should be at least 15 mm wide.

FIGURE 12a
Transverse osteotomy

FIGURE 12b
Ascending saw cut

Opening the osteotomy :

Once the osteotomy is done it is then gradually opened with either the chisel technique or with a bone spreader. With chisel technique (Fig13a) the first chisel is inserted till the pre determined depth. Then a second osteotomy chisel is placed between the first chisel and the guide wires. The 2nd chisel is inserted 10 mm less deep than the first one. Open and spread the osteotomy slowly over a period of several minutes in order to prevent fracturing of the lateral cortex. Opening can also be done with a bone spreader (Fig13b). Make sure the opening is parallel to the posterior slope and is important to note that it shouldn't collapse anteriorly or posteriorly which can affect the slope.

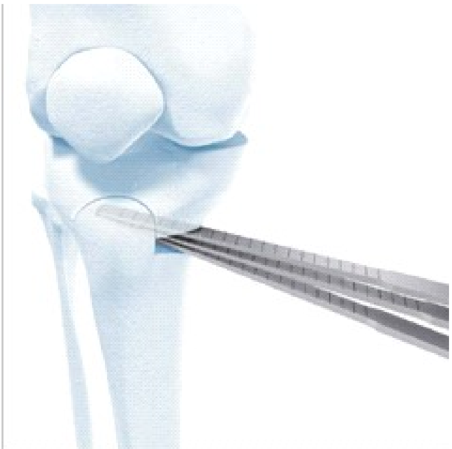

Figure 13a – Opening the osteotomy with chisel technique

Figure 13b – Opening the osteotomy with Bone spreader

Assessment of alignment & plate fixation :

The alignment rod or a cautery wire is used to confirm correction of the mechanical axis of the leg (Figure 14). Place the alignment rod proximally at the center of the femoral head and distally at the center point of the ankle joint. Axial load is applied by leaning against the foot to simulate body weight. Make sure that the weight bearing axis is passing through the Fujisawa Point. Once this is confirmed measure the height of opening and correlate it with preoperative planning. Position the plate under the image intensifier so that the solid plate segment is bridging the osteotomy. Ensure that the proximal part of the plate head is parallel to the medial tibia slope.

The proximal locking screws should be placed 1 cm subchondral to the joint line. Complete the proximal and distal screw fixation and reconfirm the final alignment under C-arm guidance. Fill the osteotomy site with blood clots. Bone grafting is routinely not need if good quality locking implants are used. Alternatively some companies provide Calcium triphosphate wedges to fill the open wedge but they are expensive. Close the subcutaneous layer with interrupted, resorbable sutures. Then close the skin with staples or interrupted sutures.

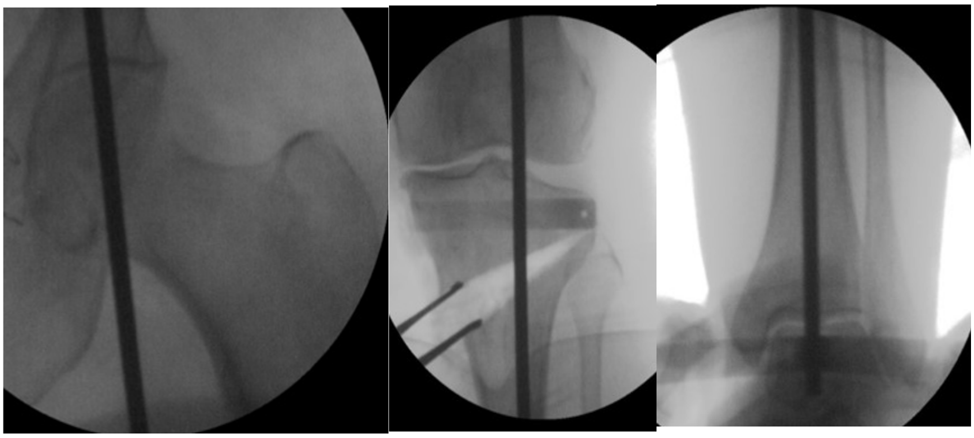

Figure 14 – Alignment carried out with alignment rod from centre of hip joint to ankle joint and ensuring that opening of osteotomy is satisfactory and cautery wire passes through Fujisawa point.

POST-OPERATIVE PROTOCOLS :

Post-operative 3 doses of parenteral antibiotics are given. Post-op X ray is done (Figure 15) and early active and passive range of movement exercises of the knee and ambulation with partial weight bearing mobilization started with help of walker on the first postoperative day and discharged home once we achieve a flexion of 90 degrees.

It is not advisable to flex the operated knee beyond 90 degrees in the first few 4 weeks of surgery. Patients are gradually encouraged to achieve full flexion by 6-8 weeks. Radiological assessment of callus is done once in 3 weeks for 1st 3 months and then at 6months & 9 months. Most of the patients start full weight bearing by 2-3months

Figure 15 – Post-op X ray of high tibial osteotomy with plate

DISADVANTAGES OF PLATING TECHNIQUE :

Difficulty in Achieving Accuracy persistently

Plates in HTO are commonly used implants, but they have their own disadvantages. Accuracy with alignment is essential in achieving good longterm results with HTO. In our set of population patients often present with significant varus. In these patients lateral ligament laxity is an important factor contributing to Varus deformity (Figure 16). Once the overall alignment is shifted to valgus the contribution of lateral ligament laxity is negated. In a supine position though we load the knee to negate the lateral ligament laxity it is difficult to predict the exact point of correction at which the laxity gets negated. This might not be very relevant in simple varus deformities. But in deformities with high degree of varus even few mm of over distraction of osteotomy can over correct the deformity (10). This might result in poor long-term outcome. Hence forth very close attention has to be paid while correcting the HTO with plating technique.

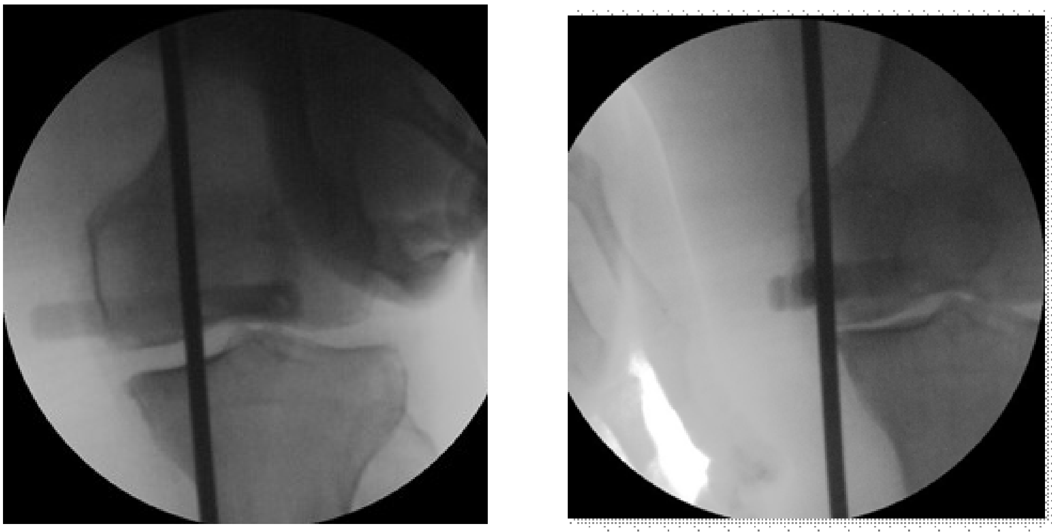

Figure 16 – Contribution of lateral ligament laxity in varus. Quiet a significant deformity of varus is corrected by negating the lateral ligament laxity.

Difficulty in corrections of varus > 20 degrees :

Large varus corrections can break the lateral cortex and can make the osteotomy unstable by causing translation of the osteotomy in addition to medial opening. Most of the patients with large varus deformity will have an associated distal femoral deformity in addition to tibial deformity. These patients will require a combined distal femoral and High tibial ostoeotomy. Its not advisable to compensate the distal femoral deformity in tibia by overcorrecting the tibia osteotomy as it results in oblique joint line which might have poor outcomes.

CONCLUSION

High tibial osteotomy is a very effective technique in addressing isolated medial compartmental arthritis in young active patients with varus malalignment. Appropriate patient selection & desired post operative alignment plays an important role in achieving good longterm results. Post operative weight bearing axis passing through the Fujisawa point and HKA between 183-186 degrees are the most important predictors of good longterm outcomes with this technique. High tibial osteotomy should often be considered as the choice of surgery in this ever increasing and challenging set of young arthritic knees.

References :

1. Pal CP, Singh P, Chaturvedi S, Pruthi KK, Vij A. Epidemiology of knee osteoarthritis in India and related factors. Indian J Orthop. 2016 Sep;50(5):518e522.

2. Functional Outcome of High Tibial Osteotomy in Patients with Medial Compartment Osteoarthritis Using Dynamic Axial Fixator -a prospective study. Amit kumar yadav, M.S (Orthopaedics), Mangal parihar, M.S (Orthopaedics), Eknath d Pawar, M.S (Orthopaedics), Divya ahuja, DNB (Orthopaedics), Sandeep gavhale, M.S (Orthopaedics) , Vikram khanna, D.Ortho,DNB,MNAMS .

3. Spahn G, M Klinger H, Harth P, O Hofmann G. Cartilage regeneration after high tibial osteotomy. Results of an arthroscopic study. Z für Orthop Unfallchirurgie. 2012;150:272e279. https://doi.org/10.1055/s-0031-1298388.

4. Miller GK. The Barrel Vault Tibial Osteotomy of Maquet for Medial Compartment Arthritis of the Knee. Arthrosc Tech. 2019 Jul 18;8(7):e793-e800. doi: 10.1016/j.eats.2019.03.018. PMID: 31485408; PMCID: PMC6714951.

5. Brinkman J-M, Lobenhoffer P, Agneskirchner JD, Staubli AE, Wymenga AB, van Heerwaarden RJ. Osteotomies around the knee: patient selection, stability of fixation and bone healing in high tibial osteotomies. J Bone Joint Surg Br. 2008 Dec;90(12):1548e1557.

6. Schuster P, Geßlein M, Schlumberger M, Mayer P, Mayr R, Oremek D, Frank S, Schulz-Jahrsdörfer M, Richter J. Ten-Year Results of Medial Open-Wedge High Tibial Osteotomy and Chondral Resurfacing in Severe Medial Osteoarthritis and Varus Malalignment. Am J Sports Med. 2018 May;46(6):1362-1370. doi: 10.1177/0363546518758016. Epub 2018 Mar 28. PMID: 29589953.

7. Hui C, Salmon LJ, Kok A, Williams HA, Hockers N, van der Tempel WM, Chana R, Pinczewski LA. Long-term survival of high tibial osteotomy for medial compartment osteoarthritis of the knee. Am J Sports Med. 2011 Jan;39(1):64-70. doi: 10.1177/0363546510377445. Epub 2010 Sep 10. PMID: 20833833.

8. Hui C, Salmon LJ, Kok A, Williams HA, Hockers N, van der Tempel WM, Chana R, Pinczewski LA. Long-term survival of high tibial osteotomy for medial compartment osteoarthritis of the knee. Am J Sports Med. 2011 Jan;39(1):64-70. doi: 10.1177/0363546510377445. Epub 2010 Sep 10. PMID: 20833833.

9. Wu LD, Hahne HJ, Hassenpflug J. [A long-term follow-up study of high tibial osteotomy in medial compartment osteoarthrosis]. Zhonghua Wai Ke Za Zhi. 2004 Apr 22;42(8):474-7. Chinese. PMID: 15144642.

10. Park JG, Kim JM, Lee BS, Lee SM, Kwon OJ, Bin SI. Increased preoperative medial and lateral laxity is a predictor of overcorrection in open wedge high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc. 2020 Oct;28(10):3164-3172. doi: 10.1007/s00167-019-05805-8. Epub 2019 Nov 28. PMID: 31781797.

ORTHOBIOLOGICS FOR OSTEOARTHRITIS

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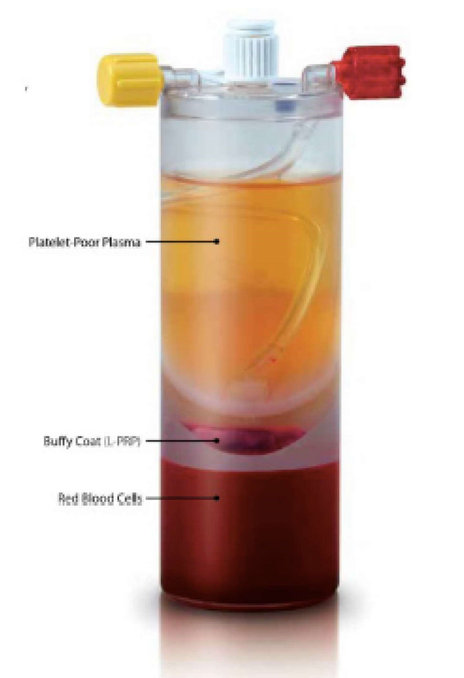
Orthobiologics involve the inclusion of biology and biochemistry in the development of bone and soft tissue replacement materials for skeletal and tissue healing. Platelet Rich Plasma (PRP) therapy is the readily available autologous "bedside" injectable orthobiologic, which is gaining widespread use. It increases healing potential, mediates inflammatory processes and reduces pain through the release of mediating amines. PRP has become an important prophylactic alternative in pain medicine and in the treatment of chronic tendon pathology.

Platelet-rich plasma is an autologous biomaterial obtained by centrifuging whole blood. PRP may be defined as a fraction of autologous plasma with platelet concentration above the baseline. Platelets are responsible for promotion of haemostasis, formation of new connective tissue and revascularization. Platelets contain more than 30 proteins including platelet-derived growth factor (PDGF), transforming growth factor (TGF- β, β1 and β2 isomers), platelet factor 4 (PF4), interleukin-1 (IL-1), platelet-derived angiogenesis factor "(PDAF), VEGF, epidermal growth factor (EGF), platelet-derived endothelial growth factor "(PDEGF), epithelial cell growth factor (ECGF), insulin-like growth factor (IGF) etc. The properties of PRP are based on the production and release of these factors when the platelets are activated. Platelets begin secreting these proteins within 10 minutes of clotting. After initial release of growth factors, the platelets synthesize and secrete additional such factors for the remaining days of their life span[1, 2]. "Thus peritendinous injection of PRP acts by limiting damage and promotes healing mechanisms in the tendons involved. It acts by its anti-inflammatory, anabolic and milieu interior altering mechanism through release of growth factors present in the platelets.

In Osteoarthritis PRP has been shown to affect local and infiltrating cells, mainly synovial cells, endothelial cells, those cells involved in innate immunity (such as macrophages) and cartilage and bone cellular components. Additionally, PRP can affect inflammation and angiogenic processes and anabolism and catabolism balance in cartilage formation and alter the existing microenvironment during disease progression. PRP may induce a regenerative response by improving the metabolic functions of damaged structures and has been shown to have a positive effect on chondrogenesis and mesenchymal stem cell proliferation. Additionally, PRP can affect inflammation and angiogenic processes and anabolism and catabolism balance in cartilage formation and alter the existing microenvironment during disease progression "The combined effects of PRP make it a potential option for management of knee OA, especially as a primary analgesic agent.



Autologous Cytokine rich serum, autologous conditioned serum are recently being promoted by companies. It is again prepared from the patient's blood and has said to improve pain and reduce inflammation. It is said to preferentially enrich the solution with a high concentration of IL-1Ra, making it a treatment option for any inflammatory condition. It is rich in cytokines that can activate the body's ability to self-heal in a targeted area. Also, in triggering the regeneration process, it increases the production of positive interleukins and growth factors that intervene in the pain cascade, causing the pain to diminish or stop. Currently the literature support on it is limited to recommend it as a treatment “option. Further randomised control trials are needed to prove its efficacy.

Which grade of Osteoarthritis can be treated with PRP?

According to literature it is most useful in Grade 1 or Grade 2 OA.

It may be used in higher grades but benefit will be minimal and limited to pain relief.

Rai D in their study of PRP for Osteoarthritis found he decrease in mean pain score is more in grades 1 and 2 than grade 3 and on subsequent follow up slight worsening occurs, which is more in grade 3[8].

Taking the blood sample

Under all aseptic precautions, about 20 ml of blood is drawn from the antecubital vein of the patient and centrifuged to get 8-10 ml of platelet enriched plasma.

PRP preparation

We use a 20 cc syringe with 2 cc of anticoagulant (CPDA) and 20 cc venous blood was drawn and mixed well. Blood is centrifuged in the Thermo Fisher Scientific Cryofuge 16. One light spin followed by a heavy spin is used. After the 2nd centrifugation the PRP was then extracted. We don't activate the platelets. The Platelet-rich plasma is transferred in blood bags and utilised for the PRP injection.

What should the concentration of Platelets?

It should 4-5 times that of normal plasma level. 1 ml of PRP can sent for testing to confirm the concentration.

In the study done by Bansal H et al. The baseline platelet count ranged from 1.91 to 3.25×10^5 platelet/µl (mean 2.3×10^5 platelet/µl). The PRP concentrate had a platelet count ranging from 12.68 to 16.2×10^5 platelet/µl (mean $14.38 \pm 1.76 \times 10^5$ platelet/µl) with a recovery of 90% (87.4-92.6%).The total platelet count infused ranged from 10.14 to 10.83 billion (10.45 ± 0.46) in 8 ml of PRP[1]

How many injections of PRP?

A single injection though useful will not provide sustained relief in Osteoarthritis.

2 injections of 8 ml each over 4 weeks is the preferred regime at our centre.

On reviewing literature some have good results with a single injections others have advocated up to 3 injections with good results.

Bansal H et al in their study demonstrated that a single injections dose of 10 billion platelets in 8 ml volume of PRP improves functional outcomes and protects the articular cartilage from further wear and tear in patients with knee OA. The PRP they used had a total leucocyte count of zero[1]. “Subramaniyam k et al. - single-blind, randomized, superiority trial of 1 vs 2 vs 3 injections at 2 weekly intervals showed three doses of PRP yields superior outcome to single and double doses at the end of one year. Repeat doses are probably needed to sustain the benefit achieved at one year[4]. “Vilchez-Cavazos F in a systematic review found that a single injection was as effective as multiple PRP injections in pain improvement; however, multiple injections seemed more effective in joint functionality than a single injection at 6 months. They consider that the available evidence is still insufficient[5].

Preparation of PRP(Leucocyte rich vs Leucocyte Poor)

Di Martino A et al. did double-blind randomized trial which showed that 3 intra-articular LR-PRP or LP-PRP injections at 3 weekly intervals produced similar clinical improvement in the 12 months of follow-up in patients with symptomatic knee OA. Both treatment groups reported a low number of adverse events, without intergroup differences. The presence of leukocytes did not significantly affect the clinical results of PRP injection[3]. “Subramanyam A used leucocyte poor PRP in 180 knees and had good results in all groups of single and multidose[4]. “Kim JH did a systematic review and metanalysis of LR- PRP vs LP- PRP and found the mean adverse reaction rates for pain were significantly higher for LR-PRP (0.152; 95% CI, 0.050-0.255) than LP-PRP (0.018; 95% CI, 0.007-0.029) (OR, 1.64; 95% CI, 1.29-2.10; P = .01). The mean adverse reaction rates for swelling were significantly higher for LR-PRP (0.098; 95% CI, 0.027-0.169) than for LP-PRP (0.014; 95% CI, 0.003-0.024) (OR, 1.56; 95% CI, 1.22-1.99; P = .02). Furthermore in their meta-analysis they found significant improvement in functional outcomes after intra-articular PRP injection regardless of leukocyte concentration. These results support the potential use of intra-articular PRP injections for the treatment of knee OA[7]. "We use an inhouse preparation of PRP in which leucocytes are not filtered out. So currently either preparation can be used in Osteoarthritis with similar clinical results but there may be increased pain and swelling with LR PRP in the initial few days.

What are the precautions that need to be taken before planning for the PRP injection?

1. Make sure the patients sugars are under control.

2. Make sure the patient is not any anti platelet drugs. If on Aspirin or Clopidrogel. The drugs should be stopped 5-7 days prior to injection.

3. Do a complete blood count, random blood sugar prior to injection

4. Make sure the patient doesn't have any local pathology like cellulitis, eczema etc.

5. Take a proper informed consent prior to the injection explaining the benefits and possible side effects.

How to give the injection? :

1. It can be given in the Outpatient clinic. Make sure to prepare the knee well. Painting with Betadine and then spirit.

2. After preparation a 10 cc Syringe is loaded with 8ml of PRP and is injected into the knee from a point just proximal to the superolateral corner of the Patella. The injection can be quite painful inform the patient accordingly. USG guided injections may also be used.

3. Mobilise the knee afterwards.

Post injection precautions :

1. Tell the patient to wait and observe the patient for at least 30 minutes post procedure.

2. No NSAID should be prescribed. Paracetamol can be prescribed for pain and SOS Tramadol with paracetamol combination may be given.

3. The patient should be advised to apply ice packs to the knee for the first day.

4. Knee mobilisation and exercises should be started from the 2nd day onwards.

5. Patient should be advised he should review in case of increased pain, fever, increased swelling of the knee.

What are the side effects and possible complications ? :

1. Post Injection flare- Feeling of soreness and increased pain right after the PRP injections. This discomfort isn't a serious concern and it usually goes away within a week or 2 from the procedure. It can be mangaged with ice and Paracetamol for the pain.

2. Swelling and Stiffness- Some PRP-treated patients report having joint stiffness after their procedures. This can be due to the initial inflammatory response from the injections of platelet-rich plasma

3. Local Infection- since the injection is intraarticular there is a chance of infection. The risk is minimal if the preparation is properly done, transported and adequate precautions like painting the site are carried out before giving the injection.

For further reading :

1. Bansal H, Leon J, Pont JL, Wilson DA, Bansal A, Agarwal D, Preoteasa I. Platelet-rich plasma (PRP) in osteoarthritis (OA) knee: Correct dose critical for long term clinical efficacy. Sci Rep. 2021 Feb 17;11(1):3971

2. O'Connell, B., Wragg, N.M. & Wilson, S.L. The use of PRP injections in the management of knee osteoarthritis. Cell Tissue Res 376, 143-152 (2019).

3. Di Martino A, Boffa A, Andriolo L, et al. Leukocyte-Rich versus Leukocyte-Poor Platelet-Rich Plasma for the Treatment of Knee Osteoarthritis: A Double-Blind Randomized Trial. The American Journal of Sports Medicine. 2022;50(3):609-617

4. Subramanyam K, Alguvelly R, Mundargi A, Khanchandani P. Single versus multi-dose intra-articular injection of platelet rich plasma in early stages of osteoarthritis of the knee: A single-blind, randomized, superiority trial. Arch Rheumatol. 2021 Jan 14;36(3):326-334.

5. Vilchez-Cavazos F, Millan-Alanis JM, Bazquez-Saldana J, Alvarez-

Villalobos N, Peea-Martize VM, Acosta-Olivo CA, Simental-Mendia M. Comparison of the Clinical Effectiveness of Single Versus Multiple Injections of Platelet-Rich Plasma in the Treatment of Knee Osteoarthritis: A Systematic Review and Meta-analysis. Orthop J Sports Med. 2019 Dec 16;7(12):2325967119887116.

6. Gupta A, Jeyaraman M, Potty AG. Leukocyte-Rich vs. Leukocyte-Poor Platelet-Rich Plasma for the Treatment of Knee Osteoarthritis. Biomedicines. 2023; 11(1):141

7. Kim JH, Park YB, Ha CW, Roh YJ, Park JG. Adverse Reactions and Clinical Outcomes for Leukocyte-Poor Versus Leukocyte-Rich Platelet-Rich Plasma in Knee Osteoarthritis: A Systematic Review and Meta-analysis. Orthop J Sports Med. 2021 Jun 30;9(6):23259671211011948.

8. Rai D, Singh J, Somashekharappa T & Singh A (2021) Platelet-rich plasma as an effective biological therapy in early-stage knee osteoarthritis: One year follow up. SICOT-J 7, 6

NEWER THERAPIES IN MANAGEMENT OF OA KNEE - MY JOURNEY

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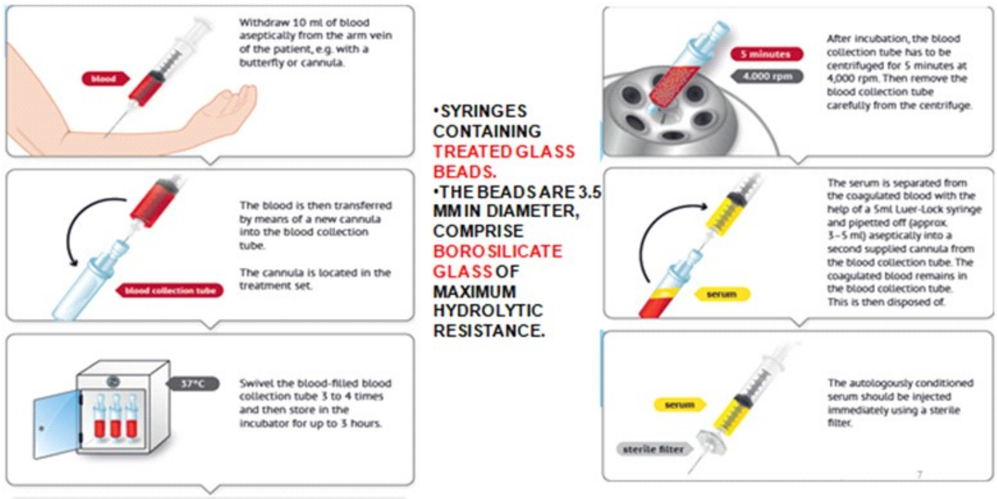
Autologous conditioned serum (ACS/ACRS)

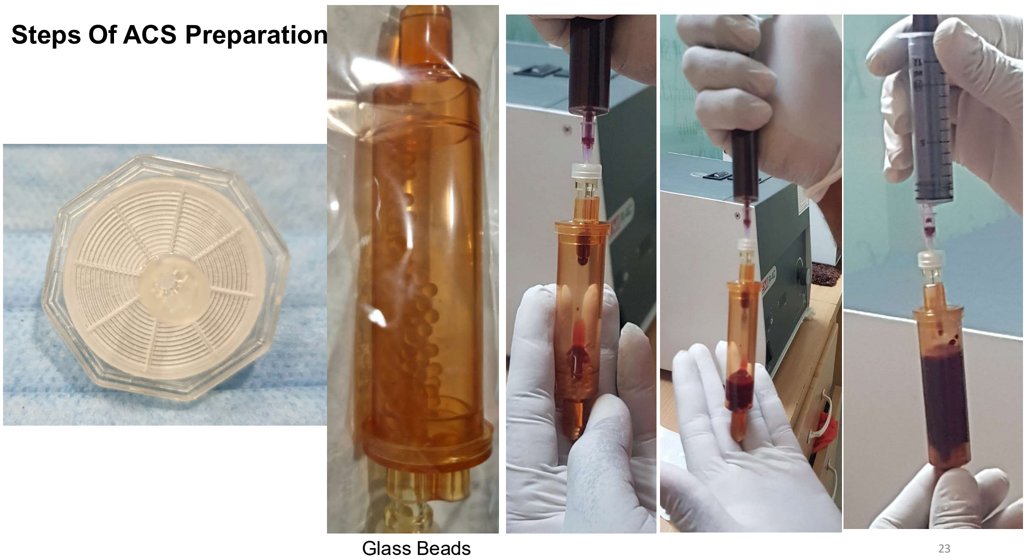
Autologous conditioned serum (acs) is an autologous blood product enriched with interleukin-1 receptor antagonist (il-1ra), a naturally occurring inhibitor of interleukin-1 (il-1). ACS is administered locally to treat certain pathologic conditions where il-1 is an important agent. Study participants treated with acs have improved pain scale and performance. However, these results are preliminary.with the assistance of innovative and tested technology, a regenerative & anti inflammatory serum is obtained from the patients own blood. the same is injected into the affected area. the body's regenerative capacity is activated by ACS. It was first used clinically in 1997. The focus of acs is on the assembly of positive interleukins & growth factors. These are crucial in intervening with the pain cascade, stopping it and subsequently triggering the regeneration process.

Given the limited data available on the composition of ACS, the mechanisms through which it produces clinical improvement, the duration of its effect and the subsequent changes in cytokine levels after repeated injections are still unknown. Although previous clinical data are encouraging and confirm the safety and clinical efficacy of this procedure, given the constraints of current studies, there should be additional trials to further confirm efficacy for the employment of acs in early osteoarthritis.

Osteoarthrosis is a disorder of synovial joints caused mainly by the uncoupling of balance between cartilage regeneration and degeneration due to focal loss of hyaline cartilage leading to proliferation of cells, the formation of new bone and remodeling of joint surfaces, osteoarthrosis is a dynamic repair process of synovial joints that may be triggered by a wide variety of causes.

The use of biological agents, including PRP and mesenchymal stem cells (MSCS) in orthopaedics, has increased exponentially over the previous years because of its autologous nature, lack of side-effects, and supposed effectiveness.





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Autologous BMAC has shown promising clinical potential as a therapeutic agent in regenerative medicine, including the treatment of osteoarthritis, cartilage defects, and it's clinical efficacy has been documented to alleviate symptoms related to knee osteoarthritis.

BMAC is a concentrate of regenerative stem cells obtained from your own bone marrow. Bone marrow is the soft, spongy tissue that is found in the center of bones, including your hip or pelvic bone. Bone marrow is the section of the body where blood is generated.

Bone Marrow Aspirate Concentrate (BMAC) is a regenerative therapy procedure that uses cells from a patient's bone marrow to initiate healing for a number of orthopedic conditions, including osteoarthritis and cartilage injuries.

BMAC, in comparison to PRP, induced significant improvement in outcomes by 29.38% on the VAS scale, 53.89% on the KOOS scale, and 51.71% on the WOMAC scale (P < . 002, P < . 01, P < . 011, respectively).

Most patients require only a single BMAC treatment depending on the degree of the injury. They last about 2 years. However, in challenging cases, if a patient experiences significant relief that plateaus, they may consider a second BMAC injection months later.

Bone marrow aspiration and/or biopsy is contraindicated patients with severe hemophilia, severe disseminated intravascular coagulation, or other related severe bleeding disorders. Thrombocytopenia, regardless of severity, is not a contraindications.

Most patients require only a single BMAC treatment depending on the degree of the injury. They last about 2 years. However, in challenging cases, if a patient experiences significant relief that plateaus, they may consider a second BMAC injection months later.

Complications are rare but can include: Excessive bleeding, particularly in people with low numbers of a certain type of blood cell (platelets) Infection, generally of the skin at the site of the extraction, especially in people with weakened immune systems. Long-lasting discomfort at the bone marrow extraction site.

Stromal Vascular Fraction (SVF) is a heterogeneous collection of cells contained within adipose tissue that is traditionally isolated using enzymes such as collagenase.

Autologous SVF therapy of degenerative osteoarthritis is rapid, effective and safe method which improves significantly the quality of life in elderly patients with medium to advanced grade osteoarthritis.

Several studies using stem cells as a treatment for arthritis have shown lasting results anywhere from six months to several years

basis of OA is degeneration and chronic inflammation of the connective tissues of joints, including the cartilage due to a long-term damaging of chondroblasts, chondrocytes and extracellular matrix caused by oxidative stress, inflammatory factors and mitochondrial dysfunction causing DNA damage.Elderly people are the most vulnerable population as effects of ageing including degenerative changes and chronic inflammation of joints are more pronounced.

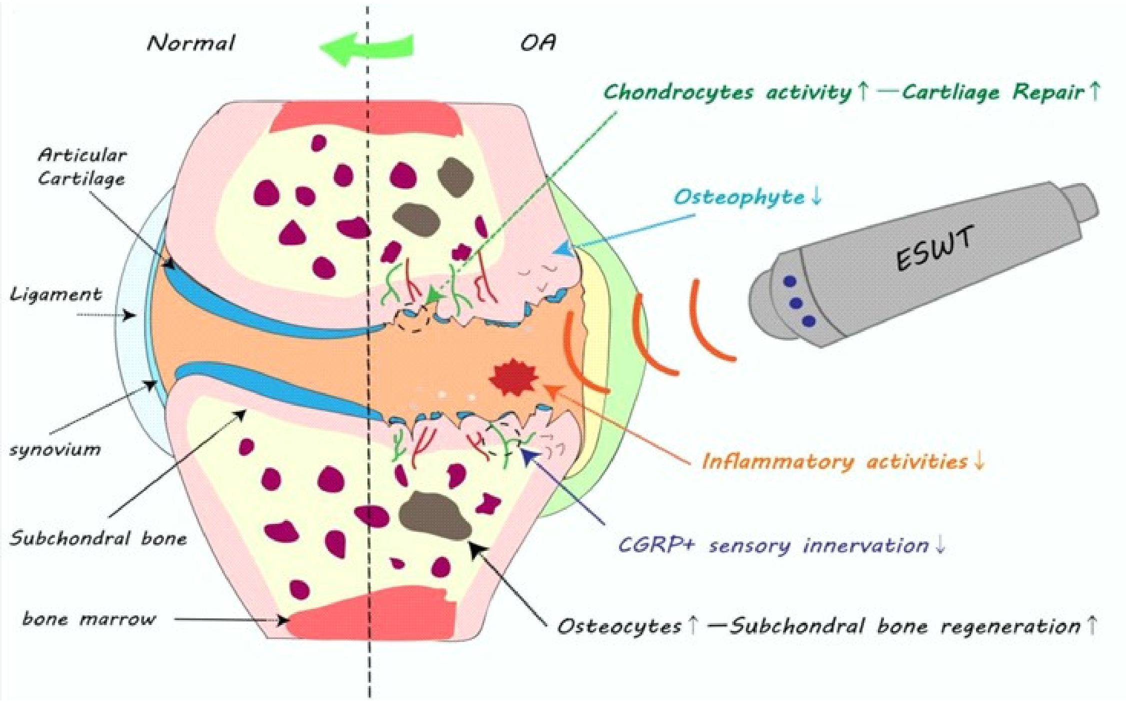
Standard OA therapy is limited to symptomatic treatments by nonsteroidal anti-inflammatory drugs (NSAIDs), steroids and joint injections of hyaluronic acid (HA). Side effects of NSAIDs are well known but less known are severe side effects of elderly who typically suffer from some level of dehydration due to a lack of feeling thirsty. Other commonly prescribed medications in elderly may also represent severe health risk in addition to dehydration and cumulative toxicity of NSAIDs, especially in long-term use.Other conventional therapy of OA includes physical therapy and arthroscopic lavage. When symptomatic conventional treatment failed, artificial joint surgery is the final standard way of available therapy. Nevertheless, such surgical treatment carries a high risk of complications, including increased risk of infection, thromboembolism, myocardial infarction, stroke, morbidity and even mortality in the elderly population. In total joint arthroplasty (TJA) of the cartilage metal-on-metal implants or ceramic-on-metal implants are commonly used. Metal nanoparticles such as cobalt, chromium, nickel, vanadium, titanium or molybdenum are released from the metal implants, as the result of wearing and corrosion, and may disseminate throughout the body, penetrate cell membranes, binding to cellular proteins or enzymes, thus modulating cytokine expression and having serious health consequences. Those may contribute to alteration of nervous system functions including memory loss, behavioral changes, depression, Parkinson's disease, Azheimer's disease, hypothyroidism and cardiomyopathy. Also chromosomal aberrations and DNA damage were described as the consequence of heavy metal poisoning released from metal prosthesis. Increased risk of cancer in patients with artificial joint was also well described and documented from large population registry in Sweden in long-term 30 years follow-up.Mainly increased risk of leukemia and melanoma, breast carcinoma in women, and prostate carcinoma in men was documented.This data demonstrates that artificial joint may represent very serious threat namely for elderly as chronic cumulative toxicity where long-term use of NSAIDs and artificial joint are the most common standard solution for patients suffering from joint pain and OA worldwide.

The association of OA with obesity, hypertension, dyslipidemia, metabolic syndrome and hyperglycemia was also described. Commonly prescribed medications of these diseases may have further dramatic negative impact on OA, especially in elderly population. Due to chronic and cumulative toxicity of standard approaches to OA, novel safe and minimally invasive medical procedures are needed, namely in elderly where the risks associated with their frailty are even more pronounced.

Extracorporeal shock wave therapy (ESWT) is a non-invasive non-surgical method, which was applied in the treatment of OA knee in recent years. Scholar Zhao carried out a clinical study on OA knee treated with ESWT in the world, and the results suggested good therapeutic effect with no major adverse reactions. He used shockwaves of 4000 pulses in total were applied at 0.25 mJ/ mm^2 and a frequency of 6 Hz/s(6,7).The mechanisms of action may be attributed to one of the following aspects. ESWT by acting on the subchondral bone, delay the structural changes in it, and hence suppress the degenerative changes in cartilage. ESWT affects some mechanical sensitive signalling pathways in the chondrocytes, thus accelerating proliferation and delaying its degeneration. Another hypothesis is that osteoporosis (OP) is closely associated with osteoarthritis, and the interaction between them may promote the genesis and development of these two.ESWT may improve the bone density in patients with osteoporosis, thus improving the symptom.

HANDLE OF ESWT

SHOCKWAVE SYSTEM



EFFECTS OF ESWT ON ARTHRITIC KNEES

ESWT and Laser therapy helps in acceleration of tissue healing, increased circulation, pain reduction, decreased inflammation.

CONCLUSION :

My journey since 2014 with all the above joint sparing or preserving procedures helped me to save many patients undergoing operative management.nearly 7500+ knees were managed with PRP/ACS/ACRS/ESWT/ BMAC.results of which are encouraging. The main success of these procedures depend on the selection of case, grade at which we opt doing these procedures,understanding of the patient, pre therapy and post therapy instructions that are followed by patients, drawing of blood, preparation of prp or acs or bmac,transporting of prepared serum or prp,time at which we inject after preparation, post therapy protocols, controlling diabetes prior to the therapy, treating any infections in the body,prior detection of any source of infection to avoid post injection infections in the joint etc…..

I do CBP/ESR/CRP/RBS prior to

giving appointment for the injection therapy except in ESWT.

I make sure Hb is above 10gm%, Platelets are more than 180,000,ESR less than 10,CRP less than 5 & RBS around 160. If any of the above parameters are altered, I defer the procedure & treat the problem detected and then take up for therapy.

I give a minimum of 3 prp at 2 weeks interval & 3 acs at a interval of 10 days with no post therapy analgesics.

My journey gave me 94.5% good results upto grade 2 oa knees & 87% in grade 3.this is an average of patients underwent newer therapies.coming to individual, PRP gave 94% good results for 2 to 2 1/2 years provided they followed the post therapy instructions.

Acs gave me 96% good results in grade 2 & 92% in grade 3 OA knee.this result lasted nearly for 3 years.

Eswt was done to patients who didn't want to get any invasive procedures , done in grade 2 & 3 also with a good results in almost 8 out of 10 cases.number of cases underwent eswt were less than 60 in the last 8 years.

We Started doing subchondral injections of PRP in OA knee under local anesthesia since 7 months & waiting for the early results of the same. Data analysis needs to be done.

After spending nearly 8 years with joint sparing non pharamacological, non surgical procedures, I'm totally convinced with the outcomes if selection & procedure is done in a meaningful way.

FURTHER READING :

Kon E, Buda R, Filardo G, Et Al. : Platelet-Rich Plasma: Intra-Articular Knee Injections Produced Favorable Results On Degenerative Cartilage Lesions. Knee Surg Sports Traumatol Arthrosc, 2010, 18: 472–479. [Pubmed]

Mangone G, Orioli A, Pinna A, Et Al. : Infiltrative Treatment With Platelet Rich Plasma (Prp) In Knee Osteoarthritis. Clin Cases Min Bone Metab, 2014, 11: 67–72. [Pmc Free Article] [Pubmed]

Rayegani Sm, Raeissadat Sa, Taheri Ms, Et Al. : Does Intraarticular Platelet-Rich Plasma Injection Improve Function, Pain, And Quality Of Life In Patients With Osteoarthritis Of The Knee? A RKapoor M, Martel-Pelletier J, Lajeunesse D, Pelletier Jp, Fahmi H. Role Of Proinflammatory Cytokines In The Pathophysiology Of Osteoarthritis. Nat Rev Rheumatol. 2011 Jan;7(1):33-42. Doi: 10.1038/Nrrheum.2010.196. Epub 2010 Nov 30. Review.randomized Clinical Trial. Orthop Rev Pavia, 2014, 6: 5405. [Pmc Free Article] [Pubmed]

International Journal Of Research In Orthopaedics Accepted "Novel Triple Therapy In Oa Knee" ijoro-2577 published in volume 9,issue 2 of IJORO,March 2023.

Can Biological Therapy With Autologous Conditioned Cytokine Rich Serum (Acrs) A Game Changer In Early Osteoarthrosis Of Knee?? – Published In International Journal of Recent Scientific Research, Volume 13 Issue2, PP. 340-345, February -2022

A Comparative Analysis Of Autologous Conditioned Serum & Platelet Rich Plasma In Chondromalacia Patellae – Published With Doi Http://Dx.Doi.Org/ 10.24327/Ijrsr. 2022.1302.0067 in International Journal of Recent Scientific Research, Volume 13 Issue 4, PP. 884-887, April - 2022

Outcome Of Prp Therapy In Rhematoid Arthritis – An Analysis Done In A Tertiary Care Hospital Accepted For Publication By Ortho & Rheum Open Access Journal. Research Article Volume 19 Issue 3 - January 2022 Doi: 10.19080/Oroaj.2022.19.556019 Ortho & Rheum Open Access J Copyright © All Rights Are Reserved By K Satya Kumar

A Comparitive Analysis Of Autologous Serum (Acs) & Platelet Rich Plasma (PRP) In Early Osteoarthrosis of Knee By Open Access Research Journal Of Life Sciences (Oarjls) Article Number Oarjls-2021-0139 Open Access Research Journal Of Life Sciences,2022,3(01),017-025.Article Doi:10.53022/Oarjls.2022.3.1.0139

Role Of Intra Articular Injection Of Autologous Platelet Rich Plasma In Osteoarthrosis Of The Knee Joint published in National Journal Of Clinical Orthopaedics Www. Ortho research journal.Com 2020; 4(4): 01-06

Role of Double Vs Triple Shot Intra Articular Platelet Rich Plasma In Early Osteoarthrosis Of Knee Publication By International Journal Of Orthopaedics Sciences Print Issn:2395-1958 Online Issn:Date of 2018 Issue4,Volume2.

BONE MARROW ASPIRATION CONCENTRATE (BMAC)

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Past President OSSAP, Kadapa

Bone marrow aspiration concentrate - refers to a concentrate of aspirated blood from bone marrow.

AIM: Bone marrow concentrate is to increase the cell count of mesenchymal stem cells and lower the concentration of hematopoietic stem cells.

Composition of BMAC :

◆ **Cellular Elements :**

- ❑ Mesenchymal cells count BMA is 624+/- 134 per cm3compared to BMAC is 2579+/-1121 per cm^3 which is a five fold increase.
- ❑ Platelets 3-4 times higher concentration in BMAC

◆ **Acellular Elements: Growth factors**

- ❑ PDGF- Platelet derived growth factors.
- ❑ TGF B: Transforming growth factor Beta
- ❑ VEGF: Vascular Endothelial Growth Factors
- ❑ BMP2, BMP7 & IL-1 RA

Harvest Technique:

Anaesthesia : Local / Regional/ Short GA

Site of Harvest and patient positioning:

- ❑ Anterior Iliac Crest- Supine Position
- ❑ Posterior iliac crest: Prone Position

Iliac Crest can be divided into 6 sectors starting anteriorly. The External iliac artery was found to be at risk in sector 1, especially in woman. The superior gluteal artery and Sciatic nerve were found to be at risk in posterior sector.

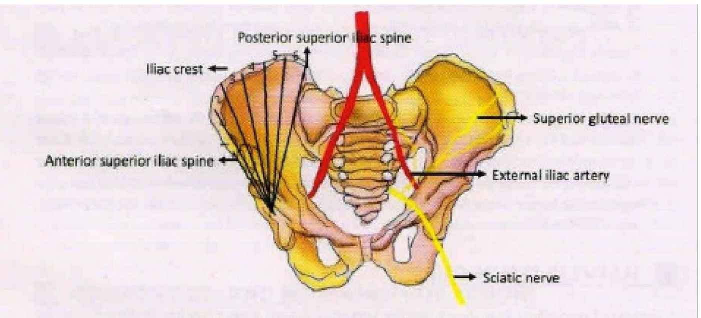

FIGURE 6.2 The Sector-Rule, as described by Hernigou et al[10]

TABLE 6.1 Comparison of anterior and posterior iliac crests for BMAC harvest

	Anterior Iliac Crest (AIC)	Posterior Iliac Crest (PIC)
Positioning	Supine	Prone
Amount of harvest possible	Less, as compared to PIC	Larger amounts possible
Yield of CTPs (9)	Less, as compared to PIC	1.6 times higher as compared to AIC
Thickness of iliac crest (10)	Zone 1: 0.8 ± 0.3 cm Zone 2: 1.3 ± 0.4 cm	Zone 5: 1.2 ± 0.5 cm Zone 6: 2.1 ± 0.2 cm
Potential structures at risk (10)	External Iliac Artery (Maximum in Zone 1 & in women)	Sciatic Nerve Superior Gluteal Nerve

Selection of Needle and syringe: 11G Jamshidi Needle with multiple side holes

TABLE 6.2 Comparison of the MIMP, SIMP and SISP techniques

Technique	Number of Skin Incisions	Number of bony punctures	Remarks
Multiple incision-multiple puncture (MIMP)	Multiple stab incisions (4-6, commonly)	One puncture per skin incision	8-10 ml from each puncture site
Single incision, multiple puncture (SIMP)	Single skin incision	Multiple punctures (4-6 commonly)	8-10 ml from each puncture site
Single incision, single puncture (SISP)	Single skin incision	Single puncture	Needle advanced and turned 90° after each aspirate

Multiple site aspiration are preferred. Heparin solution should be used to wash needle and trocar. ACD 2ml and 8ml -10ml bone marrow aspirate is collected in one syringe and total volume of 60-70ml is required.

Preparation :

- ❑ Commercial labs are available

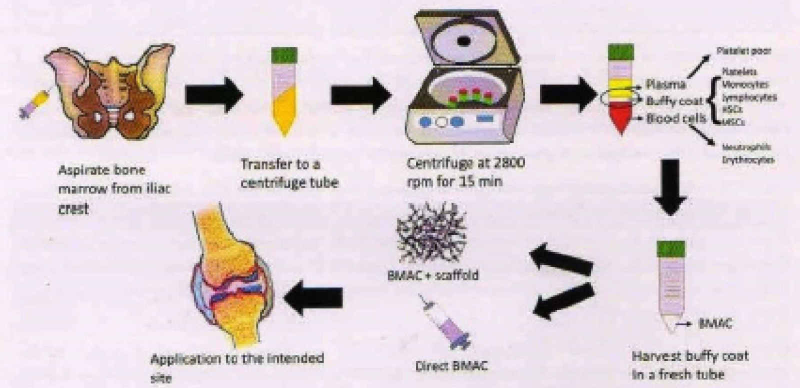

FIGURE 6.3 BMAC preparation technique

Equipment :

1. Centrifuge with 4x50 ml Rotors (Two centrifuges needed to process 100ml of marrow).
2. Conical bottom centrifugation tubes (50ml)

3. 2ml, 5ml, 10ml disposable syringes.
4. Bone marrow aspiration needles.

Chemicals :

1. FICOLL (GE and HI Media).
2. Heparin vial.
3. Phosphate Buffered Solution (PBS)

BMAC FICOLL Density Gradient Centrifugation Method.

- Collect into 50 ml centrifugation tube with 8ml of ACD (Total of 100ml)
- Dilute with equal volume of PBS
- Take 25ml medical grade FICOLL in four 50ml conical bottom centrifugal tubes.
- Layer 25ml of marrow on top with tube tipped at 45^0
- Centrifuge at 2500 rpm for 40 min. Aspirate smoky layer at the interface between plasma FICOLL gel. Add 3 volumes of phosphate buffered saline to the cells, centrifuge at 2000 rpm for 10mts. Approximate yield of BMAC from 100ml of Marrow is 5-7 ml.

VARIABILITY IN BMAC COMPOSITION

TABLE 6.3 Factors influencing BMAC composition

SNo	Factors influencing final BMAC composition (13)
1.	**Harvest** • Site of aspiration • Number of sites used for aspiration • Type of needle and syringe used • Number of punctures • Volume of bone marrow aspirated in each draw • Method of needle repositioning between each aspirate • Total initial volume
2.	**Processing** • Anticoagulant used • Use of filter • Single versus two spin separation • Centrifuge speed • Centrifuge time • G-force in each spin • Composition and amount of diluents used, if any • Whether platelet activator used • Total final volume

Characteristics of BMAC :

Mere presence of Mononuclear cells does not confirm the presence of Mesenchymal stem cells. Cell counts/ Colony forming /unit (CFU) assay & surface markers CD73, CD90 & CD105 will help to determine BMAC composition by characterisation.

Indications :

- ❑ Avascular necrosis of the femoral head.
- ❑ Non Union
- ❑ Osteoarthritis and cartilage defects
- ❑ Arthrodesis
- ❑ Spinal Fusion
- ❑ Rotator Cuff Injury and Adhesive capsulitis.

Advantages:

- ❑ On site Procedure
- ❑ Minimal Manipulation- permitted by ICMR
- ❑ Low risk of infection
- ❑ No risk of disease transmission

Now a days most of the insurance companies have approved this procedure

Keypoints :

- BMAc is a rich source of haematopoietic stem cells.
- Ficoll separation is "gold standard".
- Performed in operatioon theatre with low logistical requirement & cost.
- Will hasten the process of healing in tissues with attenuated healing potential.

Conclusion:

Bone marrow aspirate is a rich source of mesenchymal stem cells and growth factors that can aid in bone and soft tissue healing. Concentration of the marrow by density gradient centrifugation improves the stem cell yield and growth factors concentrations. Although there is a lot of variability in MBAC harvest and preparation techniques, the clinical results have been encouraging.

Off the shelf ready to inject Bone Marrow derived cultured pooled, allogenic, mesenchymal stroma cells (Stempeucel) is commercially available now & it's also approved by the insurance companies.

MENISCAL PRESERVATION

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Introduction :

The menisci of the knee joint are fibrocartilaginous semilunar tissues that perform the critical functions of stabilizing the joint and aiding in efficient load transfer as a shock absorber. They are integral to overall function of the knee and play a key role in shock absorption, joint stabilization, and possibly proprioception. At least 70%–90% of the axial load transmitted through each compartment is dissipated by its meniscus and affords the articular cartilage the protection from injury. The menisci were once thought to be vestigial remnants and thus disposable. Surgical excision was promoted as a benign procedure, and as late as 1975, complete excision was advocated for a complete recovery. The functions of the meniscus were recognized much earlier and eventually the potential harms of its excision started gaining attention. Over the last two decades, with the general adoption of arthroscopy, there has been an improvement in surgical techniques to assess and treat meniscal pathology. These improvements along with an enhanced understanding of the biomechanical properties of the menisci have led to a shift towards preservation of the menisci. In an attempt to maintain as near normal a knee as possible, techniques for meniscal repair and adjuncts to promote meniscal healing have been developed. Meniscal fragments, which otherwise would have been excised, can now be retained.

Biomechanics :

The meniscus is a fibrocartilaginous structure composed of a network of collagen fibrils (90% type I), fibrocondrocytes, and water. The arrangement of collagen fibrils has been defined as being “arcadelike.” The orientation of the fibrils mainly runs radially in the inner two-thirds of the meniscus and in a circular direction in the outer third (Fig 1). At the meniscal surface, the collagen fibrillar network is

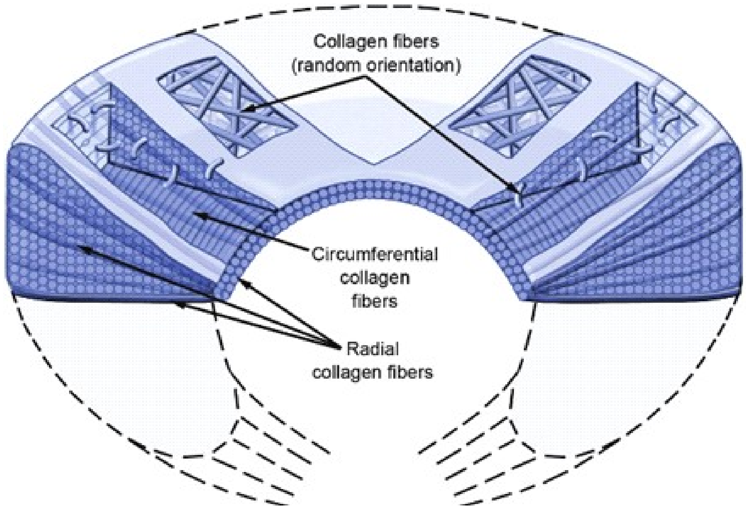

Fig 1: Three types of collagen fibers: radial, circumferential, and random.

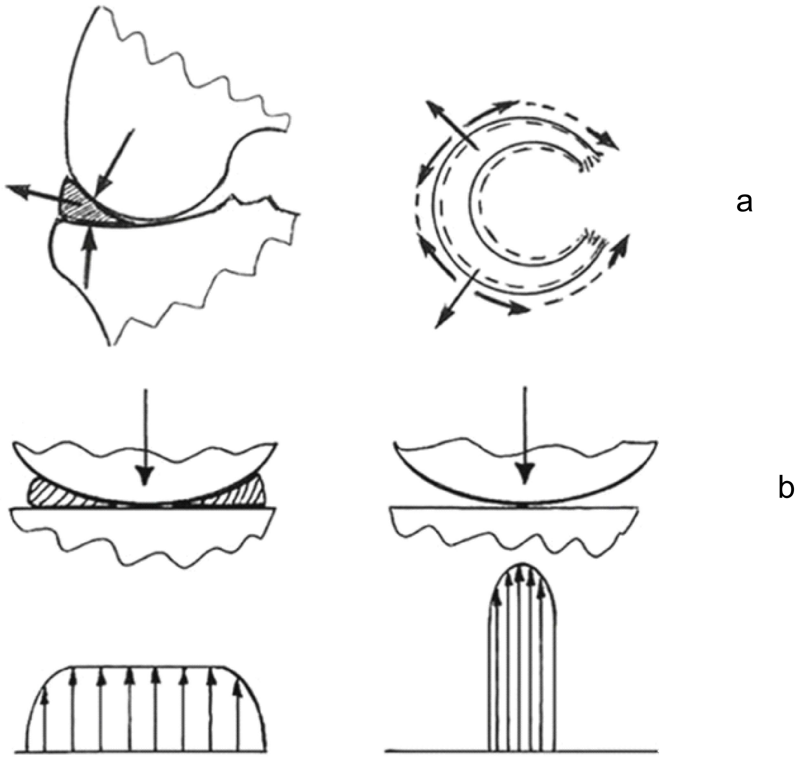

Fig 2: Load transfer through the knee joint. The menisci extrude under axial joint load and contact stress force is distributed (a). The removal of the meniscus leads to peak axial load on a smaller tibial surface (b).

woven into a mesh-like matrix. This microstructure is believed to be crucial in determining the meniscal function that consists of the conversion of the axial compressive load into a circumferential force or hoop stress, which ultimately dissipates energy and protects the cartilage surfaces. (Fig 2).

Further, the posterior horn of the medial meniscus acts as a wedge to block anterior translation. Thus, apart from contributing to the load dissipation, the medial meniscus provides anteroposterior stability due to it being an agonist to the ACL. Therefore, a medial meniscectomy combined with an ACL deficiency can lead to increased anterior tibial translation.

Meniscal healing and repair :

The vascular supply to the meniscus determines its potential for repair. The vascular supply to the medial and lateral menisci originates predominantly from the lateral and medial geniculate vessels (both inferior and superior). Branches from these vessels give rise to a perimeniscal capillary plexus within the synovial and capsular tissue. These vessels are oriented in a predominantly circumferential pattern with radial branches directed toward the center of the joint and penetrates up to 10 to 30% of width of meniscus. (Fig 3)

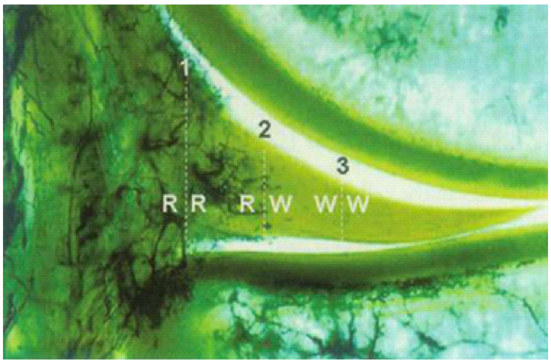

Fig 3: Frontal section of medial compartment of knee. Branching radial vessels from perimeniscal capillary plexus (PCP) can be seen penetrating peripheral border of medial meniscus. F, Femur; T, tibia. Three zones of meniscal vascularity are shown: 1 RR, red-red is fully within vascular area; 2 RW, red-white is at border of vascular area; and 3 WW, white-white is within avascular area.

classification :

Meniscal tears have been classified on the basis of their location in three zones of vascularity—red (fully within the vascular area), red-white (at the border of the vascular area), and white (within the avascular area)—and this classification indicates the potential for healing after repair. (Fig 4).

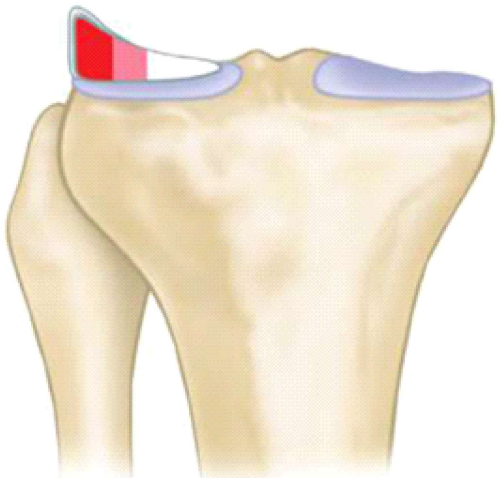

Fig 4: Zones of potential meniscal healing

According to the tear morphology they are classified into: longitudinal / vertical, horizontal / cleavage, radial, oblique & complex tears. (Fig 5).

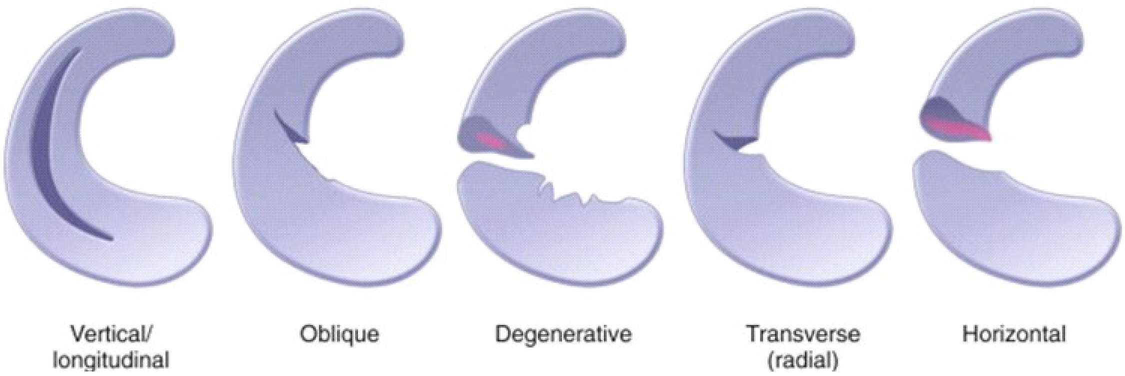

Fig 5: Types of meniscal tears

Decision making—Repair versus Resect :

Decision making regarding meniscal repair is dependent upon tear characteristics (i.e., tear pattern, geometry, location, vascularity, size, stability, tissue viability, or quality), associated pathology, previous surgeries, and patient expectations and goals. Vertical longitudinal tears with minimal deformation in the vascularized peripheral meniscus are generally considered anatomically optimal for repair owing to their vascular potential for healing. Deformed or frayed oblique flaps, radial, horizontal cleavage, or degenerative complex tears within the avascular white–white zone have traditionally been treated with resection. Patient age, activity level, and postoperative rehabilitation compliance must also be taken into account before a decision is made regarding repair versus resection.

Small, peripheral tears less than 7 mm in length and incomplete tears noted in the posterior horn of the lateral meniscus in a relatively asymptomatic patient (such as a patient undergoing concurrent anterior cruciate ligament reconstruction) can be left alone and be expected to heal.

In contrast, surgical intervention is indicated in patients with unstable tissue, substantial peripheral longitudinal tears, mechanical symptoms, or when nonoperative measures (modification of activities, inflammation reduction, and physical therapy) fail.

Meniscal repair :

When a meniscus repair is carried out under arthroscopic visualization, some common steps, which are independent of the technique, are required to be followed.

- Adequate visualization of the entire torn meniscus must be achieved to accurately diagnose the tear morphology and determine the feasibility of repair. A controlled deep medial collateral ligament release by the pie-crusting technique just below the joint line helps in visualizing posterior meniscal tears. (Fig 6)

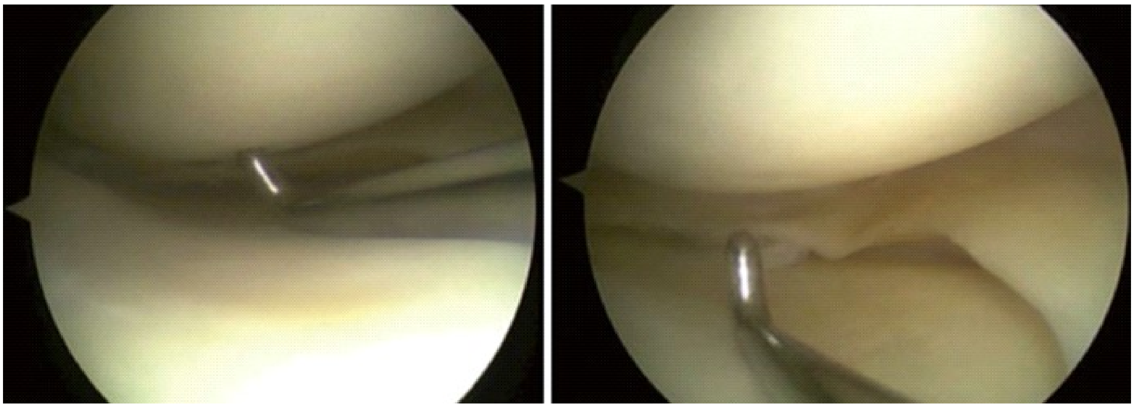

Fig 6: Release of the medial collateral ligament to access the posterior side of the medial meniscus in tight knees

• Creating the favorable biological environment to potentiate healing is a vital step. This involves debridement of granulation tissue to freshen the tear edges, peri-meniscal and meniscal synovial abrading, and trephination so as to create vascular channels. A fibrin clot from the patients' own blood can also be introduced at the repair site. (Fig 7)

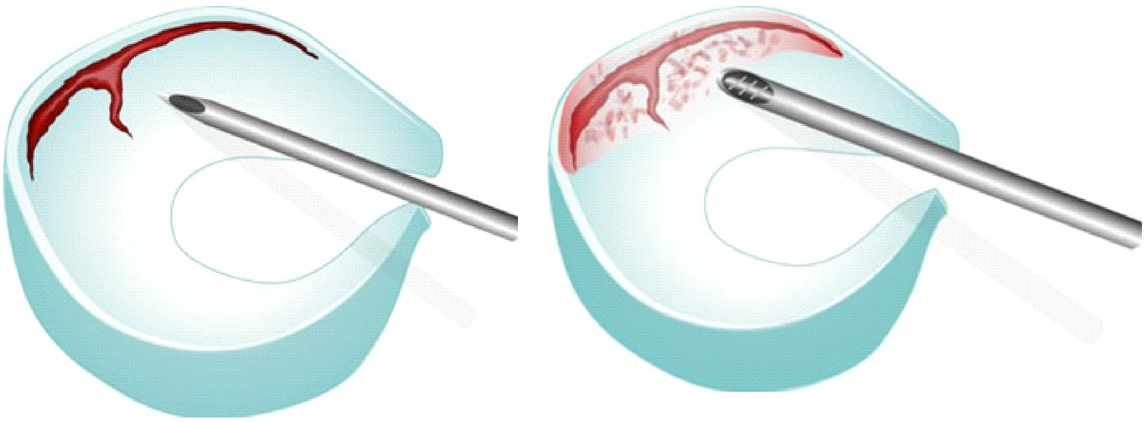

Fig 7: Trephination and Abrasion

- A limited notchplasty or microfracture of the lateral femoral condyle to deliver marrow elements into the joint during isolated meniscal tear repairs also helps augment biological healing.

The three basic techniques of meniscus repair include outside-in, inside-out, and all-inside, and each has its indications, advantages, and pitfalls.

Outside – in technique :

The outside-in technique was first described 30 years ago by Warren. Due to neurovascular risks and difficulties to repair posterior segment tears with this technique, it is mostly recommended to use for middle and anterior segments of the meniscus.

The method described makes use of two 18G spinal needles traversing the meniscus with two #0 PDS sutures. The first needle is placed from outside to pierce through the capsule to the desired area of the meniscus repair. Once the needle is placed, #0 PDS is passed across the spinal needle and retrieved from the anterior portal with a grasper anteriorly, and a small incision is made at the area of the needle down to the capsule. Moreover, this is repeated with a second needle. Once both #0 PDS sutures are passed through the meniscus and delivered to the anterior portal, a "shuttle relay" is made with one of the sutures, leaving only one suture with 2 strands outside. Then the 2 strands are tied over the capsule. (Fig 8)

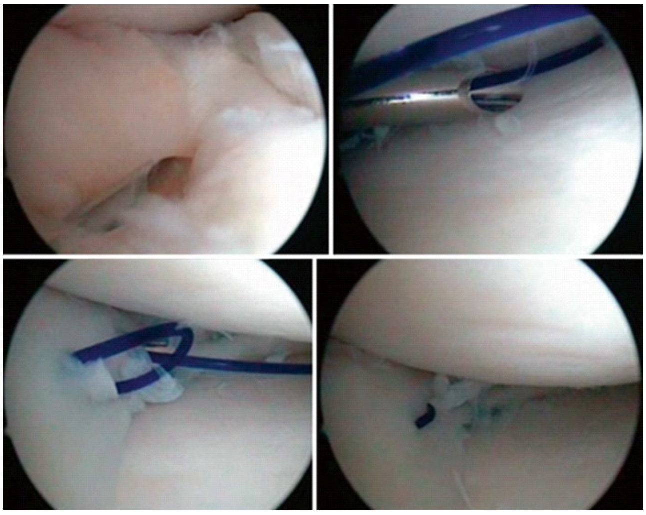

Fig 8: Horizontal outside-in meniscal repair

Inside-Out Technique :

When performing an inside-out meniscus repair, a safety incision is made on the appropriate side of the knee with the joint at 90° of flexion. On the medial side, a 3 cm skin incision is made posterior to the medial collateral ligament and is carried through fascia along the anterior border of the sartorius muscle. Following this, the sartorius is retracted posteriorly in order to protect the saphenous vein. It has been shown that care should be taken to protect the infrapatellar branches of the saphenous nerve. For meniscus repair, sutures are passed through needles from inside to outside the joint, using posterior retractors to retrieve needles in the safety zone. Once all the sutures are passed, the needles are removed and the sutures are tightened and sequentially tied over the capsule. (Fig 9), (Fig 10)

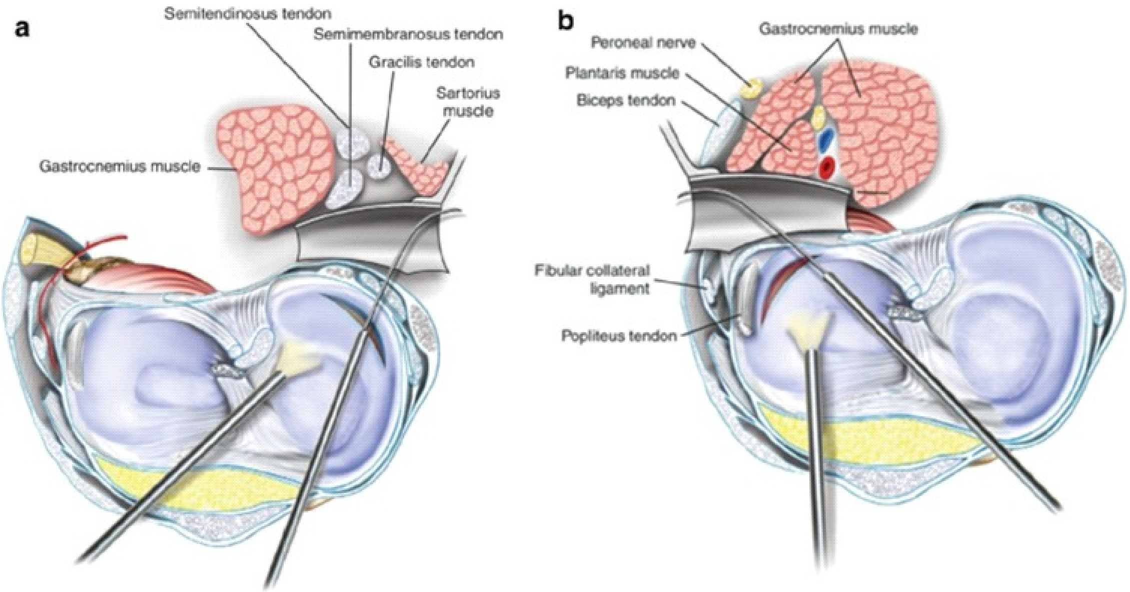

Fig 9: inside out suturing for tear in posterior horn of medial meniscus (a) and lateral meniscus (b). Needles with sutures are retrieved outside along the retractors placed through safety incisions.

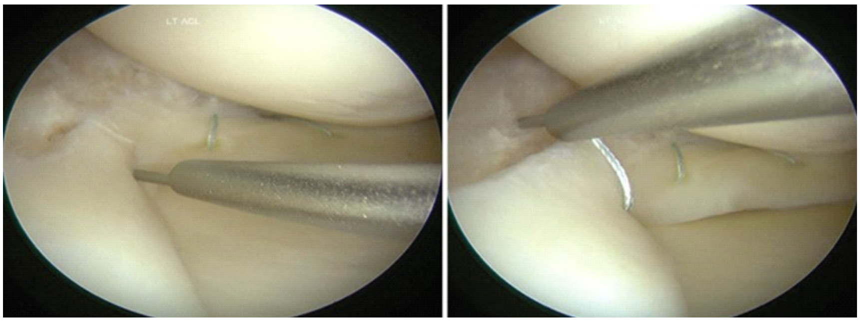

Fig 10 : Arthroscopic views showing that inside out meniscus repair of left knee medial meniscus: a suture-loaded needle being passed through the meniscus using a single-slotted straight cannula (a) and then through the meniscocapsular junction superiorly (b), to obtain a vertical mattress configuration.

Even though it is rare, some complications have been reported. Indeed, saphenous neuropathy has been reported as the major complication, which can often cause a minor nuisance. Nevertheless, these lesions of infrapatellar branches of the saphenous nerve are difficult to predict, even with careful dissection and needle placement. Therefore, although it was very popular in the 1990s, this technique has become more and more rarely used.

Fixation by All-Inside Devices :

There are several all-inside arthroscopic meniscus repair devices. The common approach of these devices is to deliver anchors containing self-adjusting sutures across the meniscus repair site. Two passes are required for a single stitch and both passes of the insertion needle place an anchor attached to the joining suture extra-articularly behind the peripheral meniscus on the capsular surface. Once deployed, the suture is tensioned to close the gap in the meniscus, and a pretied, sliding, self-locking knot is tightened to compress the meniscus repair site.

Whatever the device and location of the meniscus tear (medial or lateral) are, the implants or the sutures are routinely inserted through the ipsilateral portal for the posterior segment and the contralateral portal for the middle segment of the meniscus. Following this, the delivery system is introduced into the appropriate portal through a metallic cannula to avoid soft tissue entrapment, as well as to protect the cartilage from the needle. The system is positioned in front of the axial meniscus fragment and then passed through both parts of the meniscus and through the joint capsule. Additionally, it is useful to check the rotation of the needle, in order to make it as perpendicular to the surface of the meniscus as possible. When the needle is introduced, the device is turned 180° to be parallel to the tibial plateau, and then the first suture bar is released. The delivery needle is then positioned at least 5 mm from the first implant in a vertical, horizontal, or oblique manner and the second suture bar is released. Once carried out, the delivery needle is removed from the joint, leaving the free end of the suture out of the knee, before the suture is pulled to advance the sliding knot. Moreover, with the knot pusher, the pre-tied selfsliding knot is tightened appropriately, as the suture is cut with the knot pusher. Additional devices are inserted every 5 mm until the repair is complete. (Fig 11).

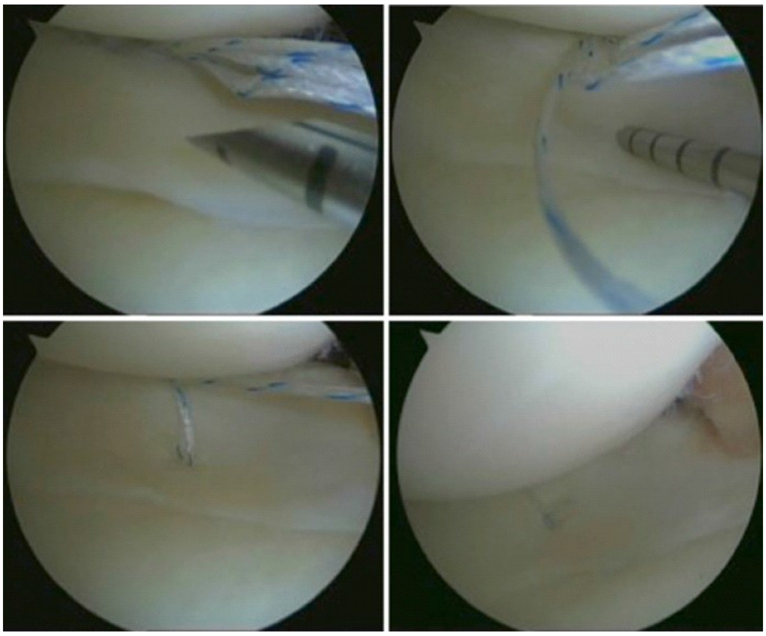

Fig 11: All-inside meniscal repair with vertical suture

Partial Meniscectomy as Salvage :

With the advances in arthroscopy and widespread performance of meniscal repairs, it is uncommon to perform a total meniscectomy today. Partial meniscectomy, however, has a crucial place in arthroscopic surgery of the knee. If a meniscal tear is not suitable for repair, either due to the site or size or tissue quality, partial meniscectomy is a valid surgical option.

The basic principles of partial meniscectomy were described by Metcalf. These are as follows: removal of all mobile fragments; avoiding sudden changes in rim contour; a perfectly smooth rim is unnecessary as some remodelling occurs; repeated probing to evaluate the tear; avoiding damage to the meniscocapsular junction to avoid the loss of hoop stresses; using both manual and motorized instruments to maximize efficiency; and when uncertain about removal or retrieval, err on the side of preserving as much meniscus tissue as possible rather than further compromising biomechanical properties.

There is a direct correlation between the amount of the meniscal tissue retained and peak contact stress on the tibial surface following partial meniscectomy. A finite element study quantifying peak pressures to amount of meniscus tissue resection showed that even a 20% resection of meniscus causes a detrimental increase in forces which may hasten osteoarthritic changes. A 65% partial meniscectomy causes maximum shear stress in the articular cartilage. The convex lateral condyle of the femur rolls on a flat or convex lateral tibial condyle, leading to worse outcomes after a lateral meniscectomy.

Radiological changes after meniscectomy :

The radiological changes in the knee joint following medial meniscectomy were described by Fairbank half a century ago. He described joint space narrowing, flattening of the marginal part of the medial femoral condyle, and sclerosis of the articulating condyles in patients who had undergone meniscectomy. These radiological signs indicate early osteoarthritic changes in the knee. The patient groups that are at higher risk of developing osteoarthritic changes after a meniscectomy are: those with ACL deficiency; those with a pre-existing chondral lesion; and obese or overweight patients with a high body mass index.

Meniscal root tears :

There are four meniscal roots (two anterior roots and two posterior roots) that firmly anchor the medial and lateral menisci to the anterior and posterior tibial intercondylar region. The biomechanical integrity of the meniscal roots is vital for the proper function of the menisci.

A direct avulsion off the tibial plateau and radial tears adjacent to the meniscal roots (with in 1cm from root attachment) on either medial or lateral meniscus are defined as root tears. These tears left untreated, result in loss of hoop tension and altered tibiofemoral contact forces. Biomechanically root tear is equivalent to total meniscectomy.

Medial meniscus posterior root tears are commonly degenerative and seen in middle aged women who are obese whereas lateral meniscal posterior root tears are more commonly seen along with anterior cruciate ligament tears. Anterior root tears are rare and are usually seen as a complication following improper tunnel placement in an ACL reconstruction or poor placement of entry point for tibial intramedullary nailing.

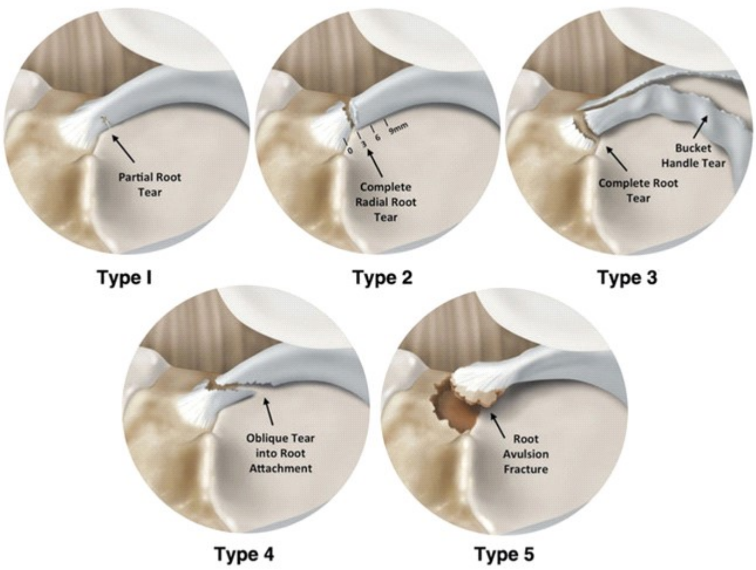

Fig 12: types of meniscal root tear.

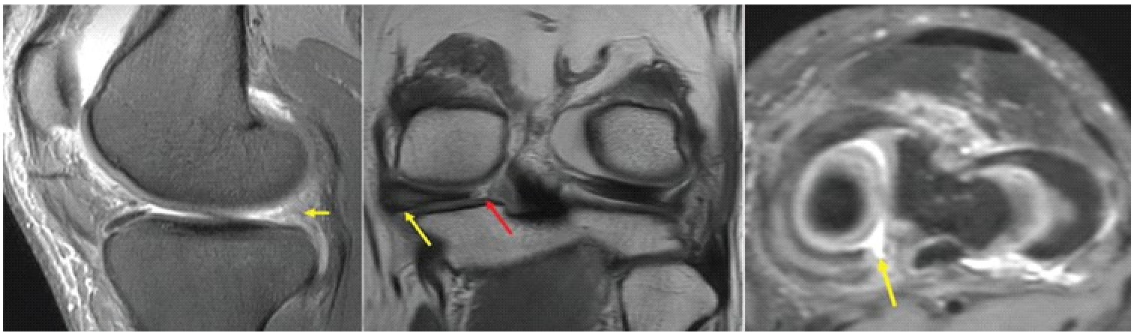

Fig 13: Magnetic resonance imaging diagnosis of medial meniscus posterior root tear – (a) The “ghost meniscus” sign, i.e., absent posterior horn of medial meniscus (yellow arrow) in Proton Density Fat Saturated [PDFS] sagittal section. (b) T1-weighted coronal section showing the site of root tear (red arrow) and extrusion of meniscal tissue outside the joint line (yellow arrow). (c) Axial section across the meniscus demonstrating the site of tear (yellow arrow).

Meniscal root injuries are notoriously difficult to diagnose due to their unusual clinical presentation. The patient may not recollect a specific traumatic occurrence. Patients with an acute posterior tear usually report a popping sensation followed by severe knee pain. Although there is symptomatic relief over a period of time and ambulation is possible, some amount of pain, especially while sitting cross-legged, is reported by these patients. A magnetic resonance imaging scan is the gold standard for diagnosing these lesions.

The treatment options for meniscal root tears include conservative management, partial meniscectomy, and repair. The decision-making process is influenced by the age of the patient, symptoms, cartilage status, presence or absence of meniscal extrusion, and type, location, and chronicity of the root lesion.

Short term symptomatic relief is seen in patients undergoing either conservative management or partial meniscectomy. However, the progressive deterioration of the chondral surfaces is not prevented. To restore hoop stress and improve the clinical and radiographic scores, an anatomic medial meniscal root repair is essential.

The recognition that a complete root tear resembles a meniscectomized knee biomechanically has led to an increased preference to repair the lesion than excision of the meniscus. Surgical repair is reserved for patients with: (i) acute symptomatic root tears with minimal arthritis, (ii) chronic symptomatic root tears, having failed conservative treatment, without significant pre-existing or varus mal alignment, and (iii) lateral meniscus root tears concomitant with ACL injuries.

There are multiple surgical techniques and fixation methods that have been described for repairing the medial or lateral root tears.The surgical techniques fall into two broad categories: pull-out suture repairs and suture anchor repairs. Recent description of surgical landmarks has facilitated accurate identification of the roots and the key is anatomic repair irrespective of the technique used. Nonabsorbable high strength sutures or tapes are used to grasp the root tissue and anchor to its anatomic bed to allow healing. (Fig 14).

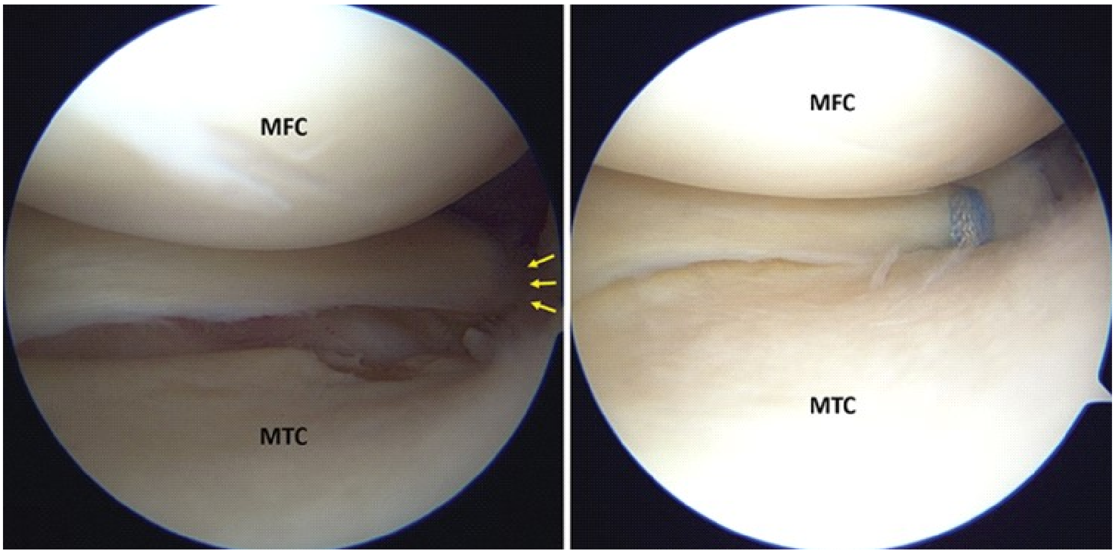

Fig 14: Arthroscopic views showing (a) Left knee medial meniscus posterior root tear (yellow arrows). (b) The meniscus is reduced anatomically after repair using high strength suture tapes. MFC = Medial femoral condyle, MTC = Medial tibial condyle.

Meniscal Allograft Transplantation :

Meniscal allograft transplantation (MAT) emerged as a potential treatment option for restoring knee biomechanics, improving and/or delaying the post meniscectomy early onset of arthritis in the knee. There is extensive evidence proving the safety and reliability of the procedure in properly selected patients with acceptable clinical and functional outcomes. (Fig 15).

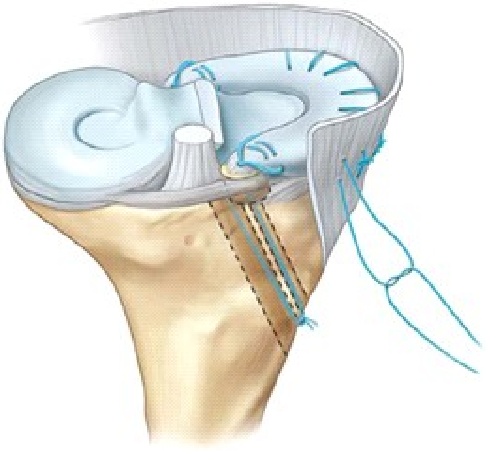

Fig 15: Completion of medial meniscal allograft transplant. A: Illustration showing final medial meniscal allograft transplant construct. B: Arthroscopic photograph of the completed medial meniscal transplant.

Meniscal allografts are fresh, fresh frozen, lyophilized, and cryopreserved, with fresh frozen and cryopreserved allografts used more commonly. Improperly sized grafts can cause higher forces across the graft and the surrounding articular cartilage. While a 10% mismatch may be tolerated, more research into consequences of mismatch is necessary.

The most common complications of MAT are graft tear, shrinkage, extrusion, and knee stiffness, especially if other procedures are performed to address mechanical misalignment.

The goal of MAT is to restore knee biomechanics by optimizing the load distribution of the tibiofemoral forces in the affected compartment, thus retarding the degenerative changes in cartilage.

Conclusion :

Although arthroplasty techniques and implant materials have improved over the past decades, the increasing longevity of the general population makes it necessary to delay the primary surgery as long as is feasible. The meniscus plays a vital role in maintaining the stability of the knee joint along with optimizing the tibiofemoral load transfer and distribution. This also helps in preserving the health of the articular cartilage. With all the knowledge gained over the years, it is vital to try and preserve the meniscus by repairing it in appropriate indications. This will hopefully prevent the early development of OA or at least slowdown the progressive degeneration of the articular cartilage. In extreme conditions, a partial meniscectomy might be unavoidable and may be carried out by attempting to preserve as much meniscus as is feasible. Biological enhancements of meniscal healing and MAT are other options in the surgeon's armamentarium to aid in joint preservation.

NON SURGICAL MANAGEMENT OF HIP AND KNEE PAINS

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Hip and knee joints are crucial in weight bearing. The axial stress contributed by the weight of an individual adds to the wear and tear of these joints. Moreover, hip and knee joints are more vulnerable for sports related injuries. Thus patients with hip or knee pain constitute a significant population in pain clinic after those with cancer pains and low back pains.

General principles of pain management:

A foolproof diagnosis is imperative for a fruitful management. Serology, radiography, MRI and ultrasound can aid in the process of diagnosis. Despite the availability of many advanced diagnostic amenities, eliciting a proper history and performing a thorough clinical examination still play a pivotal role in arriving at a fairly reasonable diagnosis.

Diagnosis and treatment can be sequential or synchronous. In sequential, we first make a diagnosis, and then a comprehensive treatment is planned, integrating pharmacological modalities with relevant interventions. On the other hand, in a synchronous strategy, an intervention is employed to serve both diagnostic as well as therapeutic purposes. Physical therapy constitute an inseparable component in the management protocol for any musculo-skeletal pain.

Pharmacological therapy :

Various drugs are available for administering orally and parenterally in multiple combinations depending on the requirement. NSAIDs along with Acetaminophen form the first line of defence against pain. They are available in oral, intramuscular and intravenous formulations. Opioids such as Tramadol can be used alone or in combination with other agents. Fentanyl and Buprenorphine are also available as trans dermal patches. Adjuvant medications are used frequently along with opioids and NSAIDs. They are steroids, skeletal muscle relaxants such as Thiocolchicoside, proteases such as Serratiopeptidase. Bisphosphonates reduce the osteoclastic activity and help in decreasing the bone pain.

Pain Interventions :

Previously, the interventions were confined to blind injections based on surface anatomy. Now the precision of the blocks is greatly enhanced by employing fluoroscopy and ultrasound in pain management, wherein the needle is safely advanced to reach the exact target site without any inadvertent vascular or neuronal injury. Once the needle is in the right position, we can inject a local anesthetic, or a steroid (depot preparation), or patient's own platelet rich plasma[PRP] based on the requirement. Alternatively in selected conditions, neurolysis can be performed by radio frequency ablation[RFA] to achieve long term pain relief.

Physical therapy :

Physiotherapy is an integral part of pain management protocol for musculoskeletal pains. Various modalities of physical therapy include heat therapy, cold therapy, massage, interferential therapy[IFT], transcutaneous electrical nerve stimulation[TENS], long wave diathermy etc.

HIP PAIN :

Pain in the hip can originate within the joint or outside the joint. Intra articular pain is often caused by a labral tear or femoroacetabular impingement in younger adults, or osteoarthritis in older adults[1]. Avascular necrosis of femoral head has emerged out as a significant contributor of hip pain in adults who recovered from COVID 19 infection in the recent times. Surgical correction is the treatment of choice for most of the said conditions. But in patients where surgery is not an option, interventional pain management strategies available. The success of regional analgesia thrives on the knowledge of sensory innervations of that region. The anterior capsule primarily supplied by the femoral and obturator nerves, and the superior labrum appear to be the primary pain generators of the hip joint, due to their higher density of nociceptors and mechanoceptors[2]. Ultrasound guided pericapsular nerve group[PENG] block came into vogue in 2018[3]. In this technique, the sensory innervation of hip joint is selectively blocked without effecting the motor component. It was initially introduced as an effective remedy to postoperative pain following hip surgeries. There after it's role is extended to chronic hip pain management. This technique is preferred over fascia iliaca plane block which includes motor innervation also[4]. Long term pain relief can be achieved by fluoroscopy guided RFA of articular branches of obturator, femoral, sciatic and superior gluteal nerves[5].

Extra-articular hip pain can have a multiple aetiology. Posterior hip pain is usually caused by piriformis syndrome, sacro-iliac joint dysfunction, referred pain from lumbar spine or hip extensor or rotator muscle strain. Lateral hip pain is usually caused by meralgia paraesthetica, greater trochanter bursitis, iliotibial band syndrome and gluteus medius muscle dysfunction[6,7,8]. They usually respond initially to conservative medical management combined with TENS. Severe cases require ultrasound or fluoroscopy guided steroid injections at respective sites.

KNEE PAIN :

There are multiple reasons for pain in the knee. Injuries and osteoarthritis top the list. Knowledge of sensory innervation of knee joint is essential to understand the concepts of regional analgesia. The fine sensory nerves supplying the knee joint are called genicular nerves. The innervation of the knee is complex, with branches originating from femoral, obturator, and sciatic nerves. The interindividual variability explains the discrepancy in the literature over the nomenclature and the origin of the genicular nerves.

Genicular nerve RFA is a new and innovative treatment option capable of decreasing pain and improving the function and quality of life in selected individuals[9].

Indications for genicular nerve RFA:

· *Patients with symptomatic knee osteoarthritis[OA], who did not respond to other modalities of treatment.*

◗ *Patients with a failed knee replacement.*

◗ *Patients who are not good surgical candidates because of compromising medical comorbidities or a high BMI.*

◗ *Patients who refuse surgery.*

◗ *Patients who have had a previously successful genicular nerve RFA, as this procedure can be repeated* *to address recurrent symptomatic knee OA.*

There are certain contraindications for this procedure which include pregnancy, acute knee injury, unstable knee joint, chronic pain syndrome, psychological overlay, uncontrolled diabetes, bleeding disorders, presence of pacemaker and an active infection of knee joint.

Biological therapies such as PRP injection have been studied in the recent times. PRP is an autologous blood product with a high concentration of platelets. PRP's effectiveness is thought to be related to the liberation of growth factors and other molecules, including platelet-derived growth factor (PDGF), transforming growth factor (TGF)-α, type I insulin-like growth factor (IGF-I), and vascular endothelial growth factor (VEGF)[10].

Intra articular steroid injections have got a limited outcome with mixed results[11]. The role of hyaluronic acid in knee joint is said to be controversial[12]. Transcutaneous electrical nerve stimulation yielded positive results in mild to moderate knee pains.

Conclusion :

Pain is not a single entity. It has physical, social, psychological and spiritual components playing in varied proportions in different individuals. Each of them needs to be addressed while managing pain. History and physical examination constitute the basis for a proper diagnosis. Choosing the right patient for a right intervention is the key to success in interventional pain management.

References :

1. Ahuja V, Thapa D, Patial S, Chander A, Ahuja A. Chronic hip pain in adults: Current knowledge and future prospective. J Anaesthesiol Clin Pharmacol. 2020 Oct-Dec;36(4):450-457. doi: 10.4103/joacp. JOACP_ 170_19. Epub 2020 Sep 26. PMID: 33840922; PMCID: PMC8022067

2. Chamberlain R. Hip Pain in Adults: Evaluation and Differential Diagnosis. Am Fam Physician. 2021 Jan 15;103(2):81-89. Erratum in: Am Fam Physician. 2021 Mar 1;103(5):263. PMID: 33448767

3. Girón-Arango L, Peng PW, Chin KJ, Brull R, Perlas A. Pericapsular nerve group (PENG) block for hip fracture Reg Anesth Pain Med. 2018;43:859–63

4. Jadon, Ashok; Mohsin, Khalid; Sahoo, Rajendra K1; Chakraborty, Swastika; Sinha, Neelam; Bakshi, Apoorva. Comparison of supra-inguinal fascia iliaca versus pericapsular nerve block for ease of positioning during spinal anaesthesia: A randomised double-blinded trial. Indian Journal of Anaesthesia 65(8):p 572-578, August 2021. | DOI: 10.4103/ija.ija_417_21

5. Bhatia A, Hoydonckx Y, Cohen SP. Radiofrequency procedures to relieve chronic hip pain, an evidence-based narrative review. Reg Anesth Pain Med. 2018;43:1–12

6. Margo K, Drezner J, Motzkin D. Evaluation and management of hip pain: An algorithmic approach. J Fam Pract. 2003;52:607–17

7. Breivik H, Borchgrevink PC, Allen SM, Rosseland LA, Romundstad L, Hals EK, et al. Assessment of pain. Br J Anaesth. 2008;101:17–24

8. Dick AG, Houghton JM, Bankes MJK. An approach to hip pain in a young adult. BMJ. 2018;361:k1086

9. Kidd VD, Strum SR, Strum DS, Shah J. Genicular Nerve Radiofrequency

1. Ablation for Painful Knee Arthritis: The Why and the How. JBJS Essent Surg Tech. 2019 Mar 13;9(1):e10. doi: 10.2106/JBJS.ST.18.00016. PMID: 31333900; PMCID: PMC6635137

10.Rodríguez-Merchán EC. Intra-Articular Platelet-Rich Plasma Injections in Knee Osteoarthritis: A Review of Their Current Molecular Mechanisms of Action and Their Degree of Efficacy. Int J Mol Sci. 2022 Jan 24;23(3):1301. doi: 10.3390/ijms23031301. PMID: 35163225; PMCID: PMC8836227

11.Ayhan E, Kesmezacar H, Akgun I. Intraarticular injections (corticosteroid, hyaluronic acid, platelet rich plasma) for the knee osteoarthritis. World J Orthop. 2014 Jul 18;5(3):351-61. doi: 10.5312/wjo.v5.i3.351. PMID: 25035839; PMCID: PMC4095029.

12. Wang CT, Lin J, Chang CJ, Lin YT, Hou SM. Therapeutic effects of hyaluronic acid on osteoarthritis of the knee. A meta-analysis of randomized controlled trials. J Bone Joint Surg Am. 2004;**86-A**:538–545

OSTEOCHONDRAL AUTOGRAFT TRANSFER FOR CARTILAGE DEFECTS

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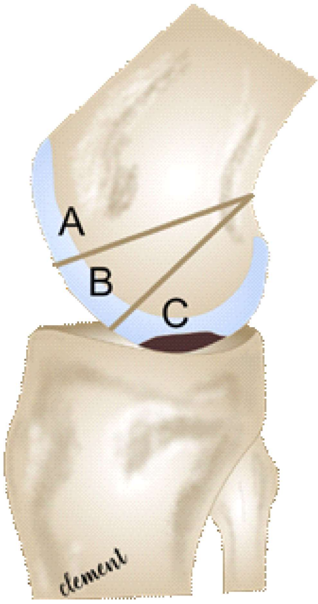
Choosing the right technique to address the cartilage lesions could be challenging. Current options for treating cartilage defects include microfracture, osteochondral autograft transfer (OATS), Osteochondral allograft transfer, Microfracture + BMAC (bone marrow aspirate concentrate) and ACI (Autologous chondrocyte implantation).

Microfracture is a minimally invasive option that fills the defect with fibrocartilage but can worsen the condition in 13% of patients and can compromise the outcomes of subsequent procedures.[2,3] It should never be done in a malaligned knee in an elderly person as it can lead to subchondral collapse and worsen the pain. We tend to reserve it for incidental asymptomatic and small lesions.

Cartilage defects can be filled with cylindrical plugs (osteochondral autograft transfer) of normal cartilage and bone harvested from relatively less weight bearing areas.[1] The defects are filled with normal hyaline cartilage. Osteochondral lesions like OCD, with subchondral bone loss can be addressed with this technique. Any gap surrounding the plug is filled with fibrocartilage and hence the term mosaicplasty.

OATS is generally indicated for **lesions of size 2 - 4 sq. cm** in femoral condyles and trochlea. It is difficult to reproduce the geometry and shape of patella lesions with OATS. It is also ideally suited for chondral lesions close to the margin of the condyle in which part of the defect margin is broken or missing **(uncontained lesions).** It results in a good hyaline cartilage repair with good bone to bone integration with good rate of return to sports in **young and active individuals**.[3]

For large lesions also it can be done, but the problems of orthogonal graft plug placement, plug necrosis and donor site availability and morbidity should be considered.



OAT procedure can be done arthroscopically or open. For a single plug transfer in the anterior and middle segment of femoral condyle (zone A and B) arthroscopic approach is feasible. For large lesions and lesions in the posterior third of the femoral condyles (zone C) approaching and placing the osteochondral plugs in a perpendicular manner is not possible and an open arthrotomy approach is preferred.

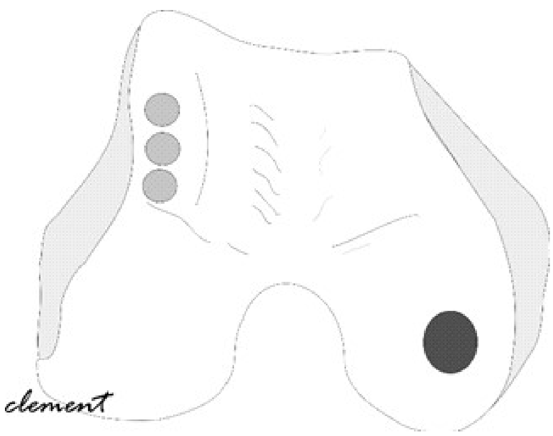
Commercial instrumentation sets are available from many manufacturers, and one should be familiar with the surgical technique for the device. Large horizontal portals and vertical central patellar tendon portals will be required.

Sizing the defect :

Sizing guides are used to determine the size and number of plugs required. One must make sure that a perpendicular approach for delivering the graft is possible.

Site of harvest :

The distal lateral trochlear ridge above the sulcus terminalis is the preferred harvesting site. This is just above the transition between tibiofemoral and patellofemoral articular surface. The superior part of the lateral trochlear ridge is important in patellofemoral articulation and should be avoided. Small plugs can be harvested from lateral intercondylar notch.

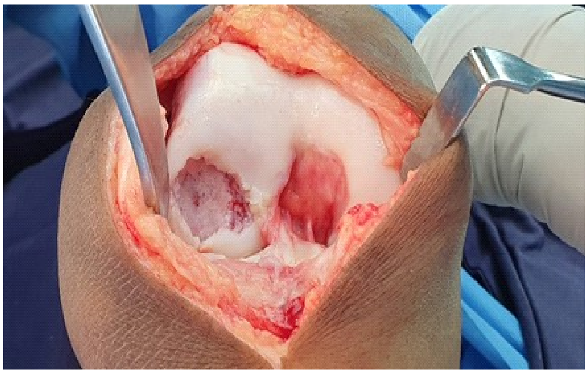


An appropriately sized harvesting tube is selected, and a plug depth of 10 to 15 mm is harvested. For osteochondral lesions a depth of 15 to 20 mm is preferred. The length of the graft and the potential angulation of the articular surface to the long axis of the graft is assessed.

The **recipient harvesting tube** is used to harvest a bone plug to a corresponding depth and angulation The depth of the recipient is checked with a sizing rod, and it should be 1 mm deeper than the donor plug length. The harvesting tube is now introduced over the defect and the donor graft is slowly tapped into the defect. Once the graft is slightly proud the tube is removed and a tamp is used to make the plug level to the articulating surface. It is preferred to leave the graft slightly recessed than proud to reduce the shear forces.

Open OAT procedure :

One should not hesitate to do an open procedure. A medial parapatellar arthrotomy can give access to most of the lesions. Perpendicular graft placement and reproducing the geometry can be easy for people in early arthroscopic career.



Complications:

A well-done OAT procedure has very few complications which could include hemarthrosis, infection and DVT. Apart from technical failures and difficulties, postoperative pain and mechanical symptoms could result from over coverage of the defect with fibrocartilage. A proud plug can result in damage to the cartilage cap from shearing forces.

Outcomes :

Histological studies have revealed

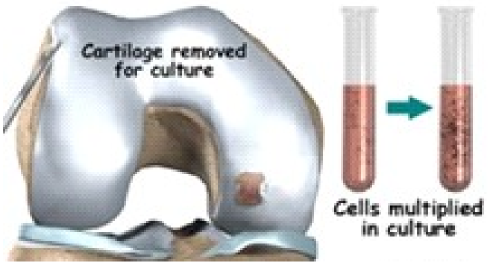
a high rate of cartilage survival and return sports of 91% have been reported. When compared to Microfracture, the clinical improvement is maintained for a longer period.[4,5,6]

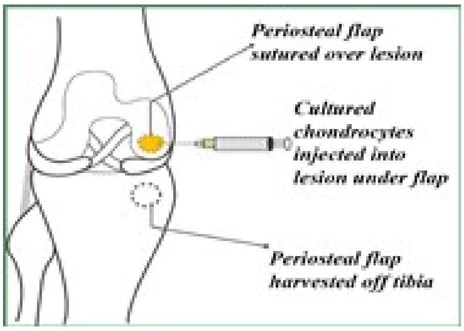
Rehabilitation:

Following the OAT procedure, toe touch weight bearing is allowed for 6 weeks. Early ROM is started and CPM can be initiated for two weeks if stiffness is anticipated. Return to sports is allowed after 6 months once quadriceps strength and proprioception are completely recovered.

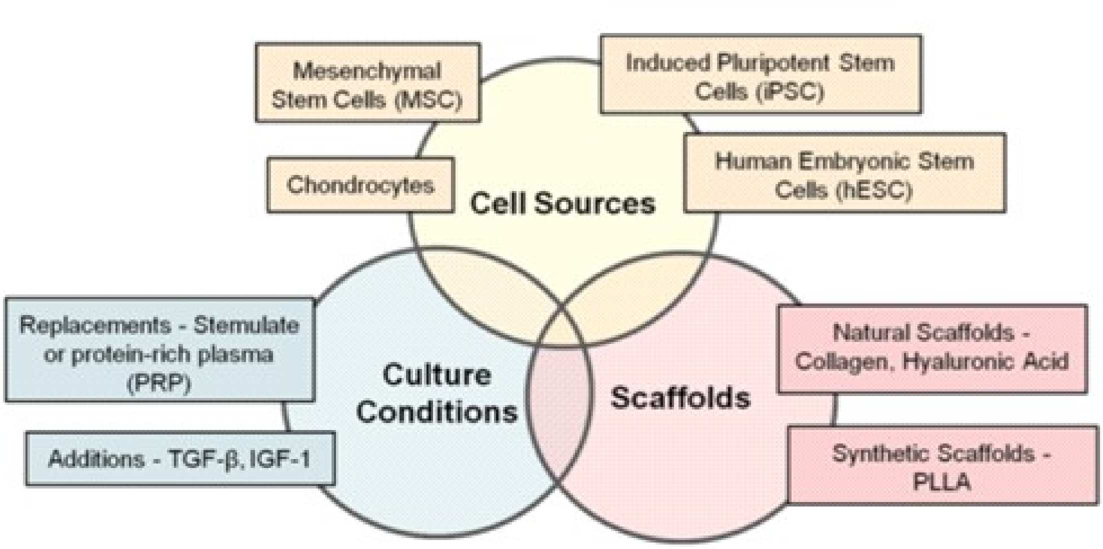
Autologous Chondrocyte Implantation (ACI) and variants :

Brittberg, 1994 pioneered the procedure employing a combination of tissue engineering to bridge larger defects that were not amenable to mosaicplasty. Since its inception the procedure has been refined as our understanding of the cartilage unit and its function improved. It is a two stage procedure, to begin the defect is identified and healthy cartilage harvested. The tissue is enzymatically digested and cultured to expand the number of chondrocytes (Fig 7). The second stage consists of freshening the defect, harvesting a suitable flap of periosteum from the proximal tibia and suturing it over the defect. The cultured chondrocytes are injected beneath the flap. The procedure will help in the development of hyaline cartilage. This is the original procedure as described by Brittberg.

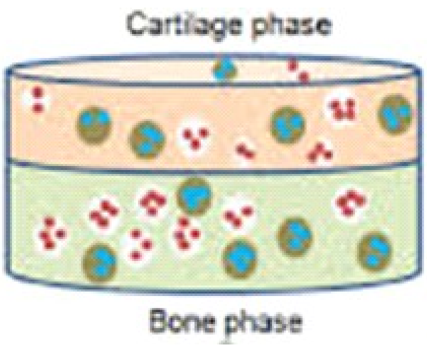




Second generation ACI utilizes a synthetic membrane to avoid the need for harvesting periosteum from the tibia, mostly a matter of convenience. With advances in tissue engineering the Third Gen ACI evolved. It combines scaffolds seeded with mesenchymal stem cells or chondrocytes, placed in tissue culture with the addition of cytokines, such as TGF-â and IGF-1 to accelerate cell growth . This membrane along with chondrocytes is fixed onto the lesion.



The final refinement is the Fourth generation ACI, which attempts to engineer the osteochondral unit as we understand it. The scaffold is bilayered, comprising of the cartilage and bone phase.



The cartilage layer is made up of type II collagen and glycoseaminoglycan. The bone layer comprises of type I collagen and hydroxylapatite. Cultured mesenchymal stem cells are loaded onto the scaffold and suitable microenvironment is created. Chondrogenesis is achieved by TGF and IGF, while osteogenesis is facilitated by BMP-2. This generates the required morphological model that mimics very closely the structure of hyaline cartilage. That said the procedure requires a well equipped tissue engineering lab to generate the compostte tissue.

Cartilage repair is essential in the young athlete in order to return to pre injury levels of activity. It also prevents acceleration of joint degeneration if these defects are left untreated. The days ahead will see the advent of 3D bioprinting where defects can be custom designed irrespective of size and shape.

References :

1. Hangody L, Kish G, Kárpáti Z, Szerb I, Udvarhelyi I. Arthroscopic autogenous osteochondral mosaicplasty for the treatment of femoral condylar articular defects: a preliminary report. *Knee Surg Sports Traumatol Arthrosc*. 1997;5:262-267

2. Gudas R, Gudaite A, Mickevicius T, et al.. Comparison of osteochondral autologous transplantation, microfracture, or debridement techniques in articular cartilage lesions associated with anterior cruciate ligament.

3. Gudas R, Kalesinskas RJ, Kimtys V, et al.. A prospective randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint in young athletes. *Arthroscopy*. 2005;21:1066-1075injury: a prospective study with a 3-year follow-up. *Arthroscopy*. 2013;29:89-97

4. Hangody L, Fules P. Autologous osteochondral mosaicplasty for the treatment of full-thickness defects of weight-bearing joints: ten years of experimental and clinical experience. *J Bone Joint Surg Am*. 2003;85(suppl 2):25-32

5. Krych AJ, Harnly HW, Rodeo SA, Williams RJ, 3rd. Activity levels are higher after osteochondral autograft transfer mosaicplasty than after microfracture for articular cartilage defects of the knee: a retrospective comparative study. *J Bone Joint Surg Am*. 2012;94:971-978

6. Krych AJ, Robertson CM, Williams RJ, 3rd. Return to athletic activity after osteochondral allograft transplantation in the knee. *Am J Sports Med*. 2012;40:1053-1059