"A CLINICAL STUDY OF FRACTURES OF PATELLA TREATED WITH MODIFIED TENSION BAND WIRING "

By

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Dissertation submitted to

In partial fulfillment for the degree of

MASTER OF SURGERY

IN

ORTHOPAEDICS

Under the guidance of

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2016

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I hereby declare that this dissertation entitled **"A CLINICAL STUDY OF FRACTURES OF PATELLA TREATED WITH MODIFIED TENSION BAND WIRING"** is a bonafide and genuine research work carried out by me under the guidance of **DR. O.B. PATTANASHETTY,** Professor and Head, Department of Orthopaedics, Shri. B.M. Patil Medical College, Hospital and Research centre, Vijayapur.

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ABSTRACT

Background & Objectives:

In a country like India where the social habits and needs, require full range of knee flexion, the patella plays an important role. The most significant effect of patella fracture are loss of continuity of extensor mechanism of knee and potential incongruity of patello-femoral articulation. So it is necessary to preserve the patella and extensor apparatus. Hence the main objectives of this study are: To study the functional outcome by early mobilization, to study the complications of tension band wiring, to clinically evaluate the tension band wiring technique for fracture patella, to study the mode of injury for fracture patella.

Methods:

The present study consists of 30 selected cases of fractured patella treated by modified tension band wiring at Shri B M Patil Medical College Hospital and Research Centre , Vijayapur from December 2014 to March 2016.

Results:

In the present study 21 (70%) had excellent results, 7 (23.33%) had good results and 2(6.66%) had poor result.

Interpretation and Conclusion:

Early mobilization of the knee restores quadriceps power and range of knee motion within a short period. Excellent range of movement was achieved in 70% of cases, which is comparable to previous literature.

Keywords: Patella; Kirschner wire; Tension band

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INTRODUCTION

The patello-femoral joint is the heaviest-loaded joint in the body. Any compromise of the joint surface is likely to lead to degenerative joint disease. It is, therefore, highly desirable, in patellar fractures to strive for anatomical reduction of the joint surface and stable fixation. In addition, a treatment goal is restoration of function of the knee extensor mechanism.

The patella is of importance for the extension of the knee joint. It increases the force of the quadriceps apparatus by improving the leverage. In addition, it protects the anterior articular surface of the distal femur against external violence, but may easily be injured due to its unprotected position.

Fractures of the patella are common and constitute almost 1% of all skeletal injuries.[1] Opinions differ widely as to the proper treatment of a fractured patella. Haxton[2] in 1945 and Kaufer in 1971[3] on the basis of experimental work showed that the patella was not without importance in the knee joint and was responsible for improving its efficiency. It is because of this that the need to preserve the whole or part of the patella becomes imperative, especially in a country like India where social habits and needs require a full range of knee flexion. Several methods of internal fixation of fractured patella have been advocated. This dissertation is directed towards the clinical evaluation of the modified tension band wiring technique for the fractured patella.

OBJECTIVES OF THE STUDY

1. To study the functional outcome of modified tension band wiring in fracture patella and its associated complications.

REVIEW OF LITERATURE

History and Review of Literature:

A review of the literature reveals a wide diversity of opinion as to the proper treatment of the fractured patella.

In 1877, Cameron in Glasgow, Scotland, performed the first operation on a fracture of the patella. He opened the knee joint and wired the fragments together. The same year Lord Lister performed the same operation and subsequently published the first paper on the operative treatment of fracture of the patella.[4]

In 1907, Willis is probably the first to perform total patellectomy. He excised the patella in three cases for fracture and reported excellent results.

Heinock in 1909, stated that although patella seemed unnecessary for locomotion, its removal was invariably followed by impairment of power and by some functional loss. He concluded that patellectomy was to be condemned in uncomplicated transverse fractures and that it deserved consideration in comminuted fractures only as a measure of last resort[5]

In 1915, Phemister advocated direct repair of the patella fracture using silk suture.

W.E Gallie in 1924 reported a case of ununited fractured patella successfully treated by suturing the fragments using fascia lata passed through drill holes, but subsequently recommended using achilles tendon in 1927 to close the defect.

In 1935, Thomson reported five fractures of the patella treated by surgical excision of the smaller fragments and capsular repair. Although he had advocated partial patellectomy in the treatment of certain fractures, he felt that total patellectomy should be avoided because of the impairment of the leverage of quadriceps during extension of the knee.[6]

Wass S.H. in 1942 called attention the pathologic ossification occurring following patellecomy. He observed that the small ossifications are of no significance but the larger ones may account for the pain and limited motion.

Cohn in 1944, found degenerative changes on the femoral condyles of patellectomised rabbits and concluded that the procedure should be avoided if possible in human patients.[7]

In 1945, Haxton on the basis of experimental work showed that the patella was not without importance in the knee joint and was responsible for improving it efficiency. He demonstrated that the power of extension is greater with the knee at 30° flexion than at 60°, 90° or 120°. By comparing patients after patellectomy with normal people, he showed that after patellectomy much of this power is reduced as the knee extension is lost.[2]

Hans Jensenius in 1951 presented a brief review of some of the arguments in the literature for and against excision of the fragments in patella fractures. The principle argument in favour of patellectomy was that the risk of arthritis is avoided and that it offers a more rapid and uneventful recovery. Arguments against patellectomy were that the patella provides a normal protection for the femoral condyles which are exposed to trauma after excision, that the patella glides with less friction over the articular surface of the femur than does the quadriceps tendon, and finally that the patella acts as an important lever arm to increase the force from the quadriceps muscle as it is applied to the tibial tuberosity. He advised that, when possible, at least one large patellar fragment either proximal or distal should be maintained on excision of any comminuted fragments.

Watson - Jones in 1952,reported the pathology of avascular necrosis of the patella in a case of transverse fracture treated by screw fixation.

In the same year O'Donoghue and associates, by a series of muscle tests confirmed the findings of Haxton, that the strength of quadriceps rarely approached normal after patellectomy.

McKeever in 1955 designed the first patellar prosthesis.

In 1963, Douglas CD.Netto ,evaluated long term results of repair and excision of the fractured patella. He followed 76 cases of fractured patella requiring operation between 1936 and 1956 and 26 more patients between 1958 and 1961. He concluded that the function of the knee joint, after repair of a transverse fracture of the patella is rather better than after excision of a comminuted fracture.[8]

Smilie IS in 1970, recommended fixation by a screw.[9]

G. Berensten and L. Kalabay stressed the importance of early motion of injured knee joint in all the operations performed for fracture patella.

The AO group (Muller1970), introduced anterior application of one or two wires, inserted through longitudinally drilled holes for which the so called “Zuggurtungs osteosynthese” is employed.[10]

In 1971, Anderson suggested circumferential wire loop or the Denergre Martin method. He also recommended inserting metal wire through the longitudinally drilled holes.

In 1980, Weber M.J. Janecki, McLeod and Thompson compared the efficacy of various forms of fixation of transverse fractures of the patella. Twenty five fresh cadaver knees were fractured transversely and fixed using the following techniques circumferential wiring, tension band wiring, Magnusson

wiring and a modification of tension band wiring. The knees were mounted in a machine capable of measuring quadriceps force, flexion angle and fracture separation simultaneously.

Separation of fracture fragments was much less with the Magnusson wiring and modified tension-band wiring than with circumferential wiring or standard tension band wiring.[11]

In 1981 Dudani B and Sancheti K.H. treated 15 cases of fracture patella with tension band wiring out of which 10 males and 5 females with the age group between 20 to 50 years and found excellent end results in all cases.[12]

In1984 Ma. Y.Z., Zhang Y.F. and Yeh Y.C., treated one hundred and seven patients with fractures of the patella by percutaneous suture with stainless steel wire.[13]

In1987 Marya S.K., Bhan S. and Dave P.K. compared knee function after patellectomy and osteosynthesis with a tension band wire for almost identical fractures of the patella. Following patellectomy only about half the patients achieved excellent results while after osteosynthesis results were obtained in 80% of patients.[14]

Benjamin et al performed a biomechanical evaluation of four types of fixation of transverse patella fracture. They found that screw fixation alone was adequate in good bone stock and the modified tension band wiring was superior to the Lotke longitudinal anterior band and the magnusson wiring.[15]

M.J Curtis in 1990 stated that the ideal internal fixation for the fractured patella should be strong enough to allow early mobilization to reduce post traumatic stiffness and perhaps help in healing of articular cartilage. This study was done by comparing two methods of internal fixation of fractured patella

in cadavers, a modified AO tension band technique and combination of cerclage wiring and a tension band.[16]

Carpenter et al found that combining inter fragmental screws with tension band principle appears to improve the stability over the tension band screws alone for a transverse fracture patella.[17]

Anatomy of the Patella and Knee joint[18, 19]

The knee joint is the largest and most complicated hinge joint in the body formed by the distal end of the femur, the patella and the proximal end of the tibia. Its stability is due to the strong ligaments in and around the joint and surrounding muscles rather than the configuration of the joint. In all positions of the joint the patella is in contact with the femur and the femur with the tibia. The bones do not interlock with one another, but the area in contact is large. The capsule which envelopes the joint is imperfect and incomplete. Proximally it is attached to the femur around the articular margins of the condyles and the intercondylar notch posteriorly.

On the lateral condyle the attachment includes the pit for the popliteus tendon. Distally it is attached to the tibia around the articular margin except where the tendon of popliteus crosses the joint. The capsule is supplemented and strengthened by accessory ligaments by tendons or expansion from them and by deep fascia. The ligamentum patellae replaces it in front. At the back it is strengthened by the oblique posterior ligament. The medial ligament overlies the joint on the medial side and the lateral ligament on the lateral side. In the interval that separated those two ligaments from the ligamentum patellae, the capsule is subcutaneous and is strengthened by the fascia lata and expansions from the lateral

and medial vastii which fuse with it. These expansions from the vastii are called the patellar retinacula.

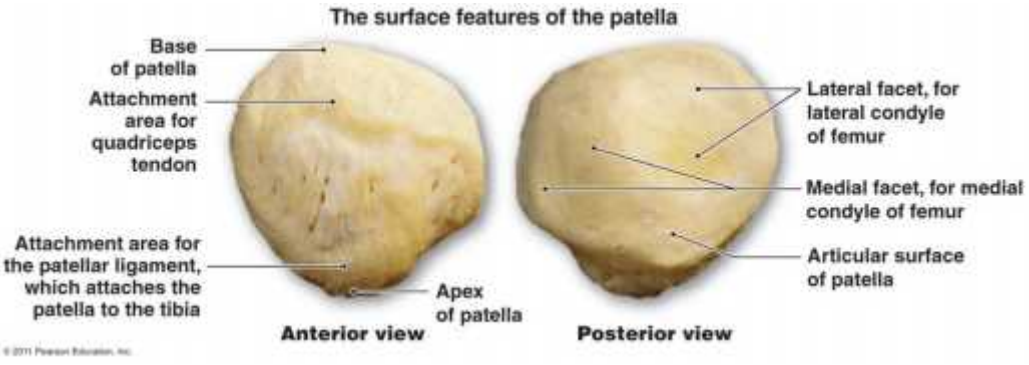


Fig. 1 Patella anterior and posterior view

The medial ligament consists of 2 parts, the deep and the superficial. The deep part is attached to the articular margins of the femur and tibia on their medial aspect and is continuous with the capsule in front and behind. It is attached intimately to the medial meniscus.

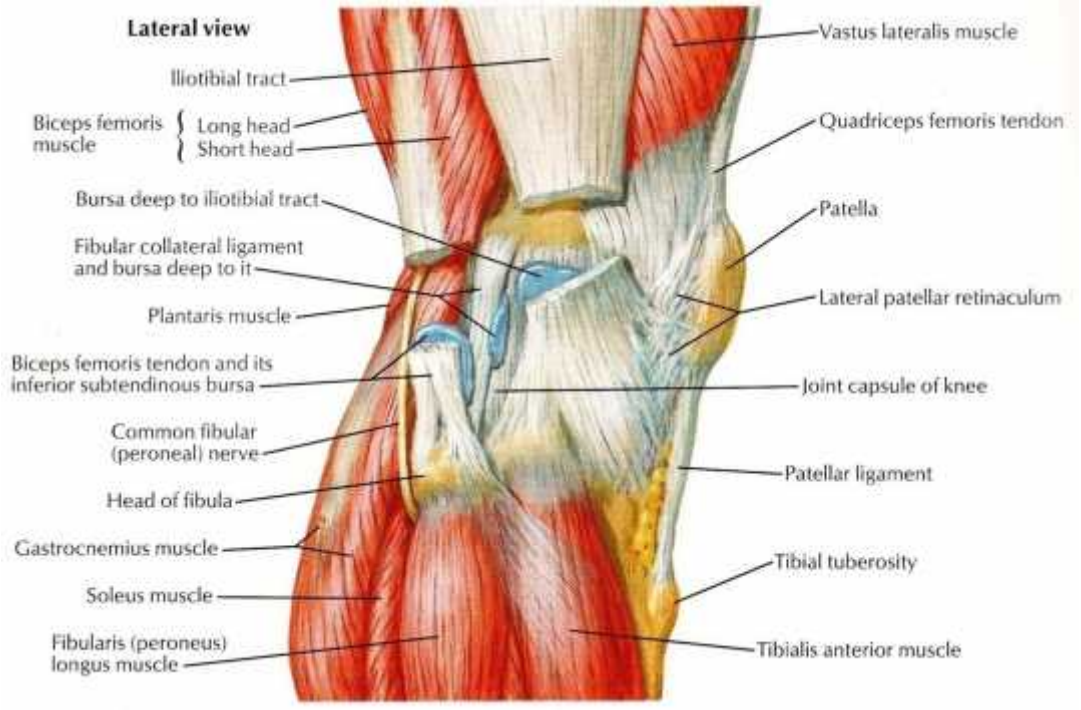


Fig. 2 Knee joint lateral view

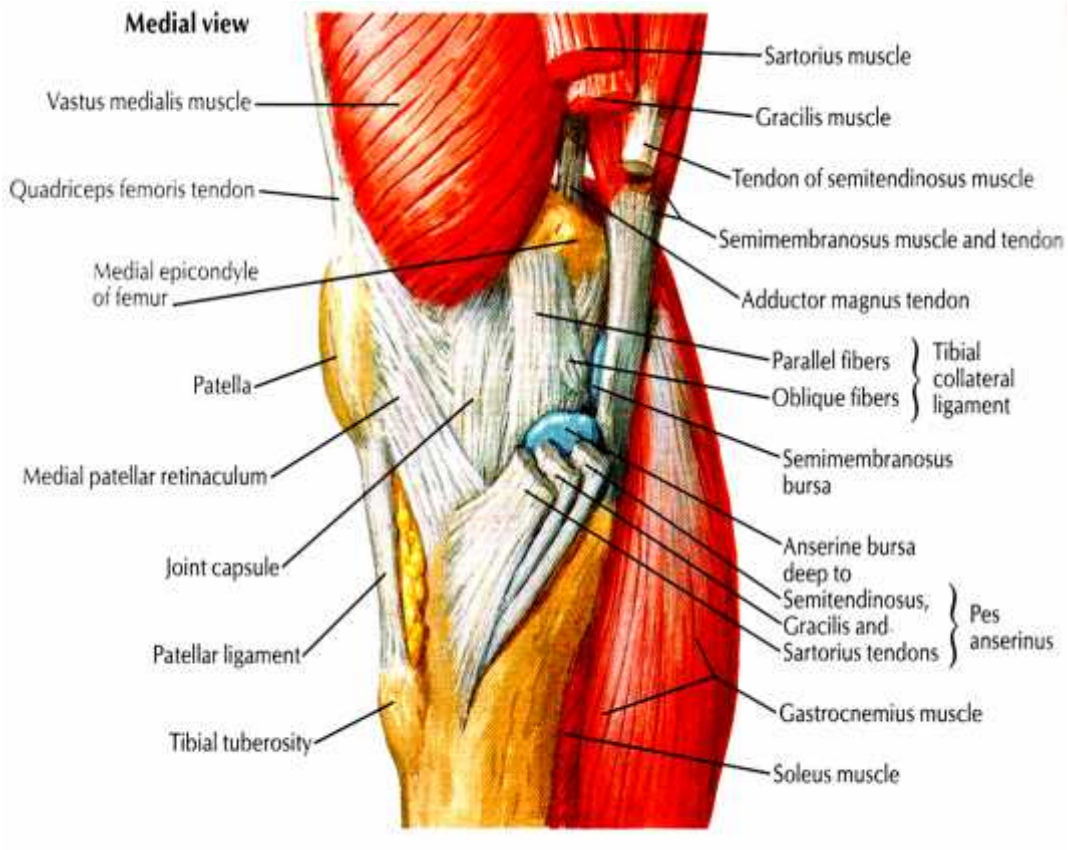


Fig. 3 Knee joint medial view

The superficial part is a strong flat triangular band arising from point immediately below the adductor tubercule and is inserted into the medial surface of the shaft of tibia distal to its tubercle.

The lateral ligament is a round band which arises from the lateral epicondyle of the femur immediately proximal to the groove for the tendon of popliteus and is attached distally to the upper surface of the head of the fibula. The oblique posterior ligament (of Winslow) is a broad slip that springs from the semimembranous tendon at the back of the medial tibial condyle and spreads upwards and laterally towards the lateral femoral condyle fusing with the capsule.

The synovial membrane lines the capsule and at its bony attachments, is reflected on to the upper and lower surfaces of the semilunar cartilages but is

absent from the patella. It separates the ligamentum patellae from the infrapatellar pad of fat and lines deep surface of the quadriceps tendon.

The semilunar cartilages are two crescentic plates of fibro-cartilage which are placed on the condylar surface of the tibia. Each has two horns which are attached to the intercondylar area on the proximal surface of the tibia. They deepen the surface upon which the femur rolls and being movable, they fill up the gaps which would otherwise arise during movements of the joint.

The cruciate ligaments are so named because they cross each other like the limbs of the letter 'X'. The anterior cruciate ligament springs from the anterior part of the tibial plateau in front of the tibial spine and extends upwards and backwards to a smooth impression on the lateral condyle of the femur well back in the inter condylar notch. The posterior cruciate ligament is attached to the posterior part of the tibial intercondylar area and passes upwards, forwards and a little medially and is attached to the anterior portion of the lateral surface of the medial condyle of the femur. It receives one or two strong slips from the posterior horn of the lateral semilunar cartilage.

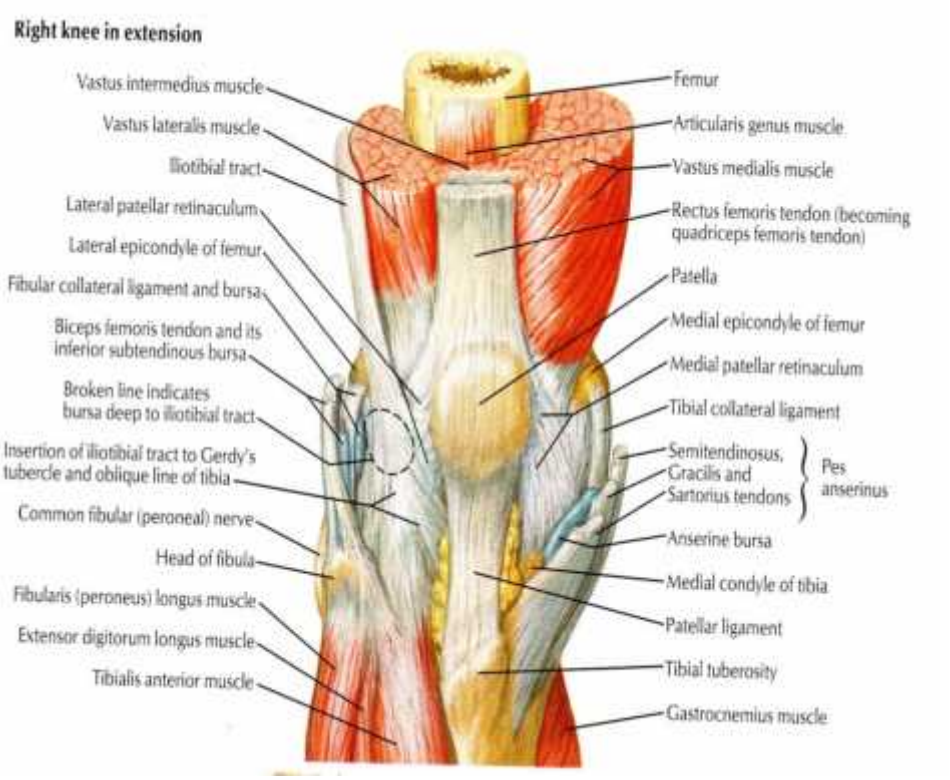


Fig. 4 Knee joint anterior view

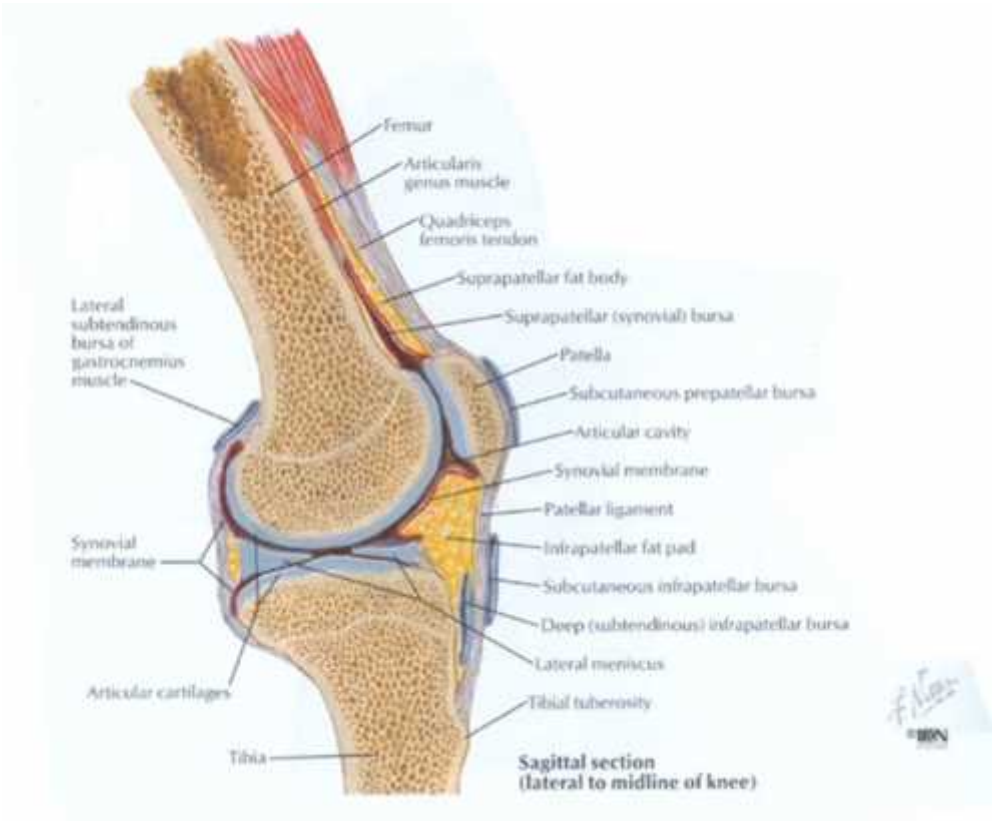


Fig. 5 Knee joint saggital section

The transverse ligament of the knee is a fibrous band which stretches across from anterior part of one semilunar cartilage to the other and by means of this one meniscus is partly controlled and partly accompanied by the other in its displacement during knee movements.

Osteology of Patella[18]

The patella, the largest of the seasmoid bones, is in front of the knee joint embedded in the back of the tendon of the quadriceps femoris. It is flattened, triangular below, curved above and has anterior and posterior surfaces, three borders and an apex. In the living subject in the erect attitude, its lower limit lies more than 1cm above the line of the knee joint.

The anterior surface readily palpable is convex, perforated by nutrient vessels, and marked by numerous rough, longitudinal striae. It is separated from the skin by a bursa and covered by an expansion from the tendon of the quadriceps femoris, this expansion is continuous below with the superficial fibers or the so called patellar ligament, which is of course, the tendon of the quadriceps. The posterior surface presents in its upper parts a smooth, oval, articular area divided into two facets by a smooth vertical ridge, which corresponds to the groove on the patellar surface of femur. The lateral facet is broader and deeper. The ridge is also covered surface, which really consists of two regions angulated with respect to each other by the ridge.

A narrow strip, broader above than below and often inconspicuous in the macerated specimen, is marked off from the medial part of the medial facet. The strip comes into contact with the medial condyle of the femur in extreme flexion of the knee joint. Below the articular surface the apex, which points downwards,

is roughened in its lower part for the attachment of the ligamentum patellae, its upper part is covered by the infra patellar pad of fat.

The superior border is thick, and slopes from behind, downwards and forwards, except near its posterior margin, it has attached to it the parts of the quadriceps femoris which is derived from the rectus femoris and vastus intermedius.

The medial and lateral borders are thinner and they converge below, they give attachment to those portions of the quadriceps femoris which are derived from the vastus medialis and lateralis. Near the junction of the base and lateral border there is small, shallow, circular depression into which a part of the tendon of the vastus lateralis is inserted.

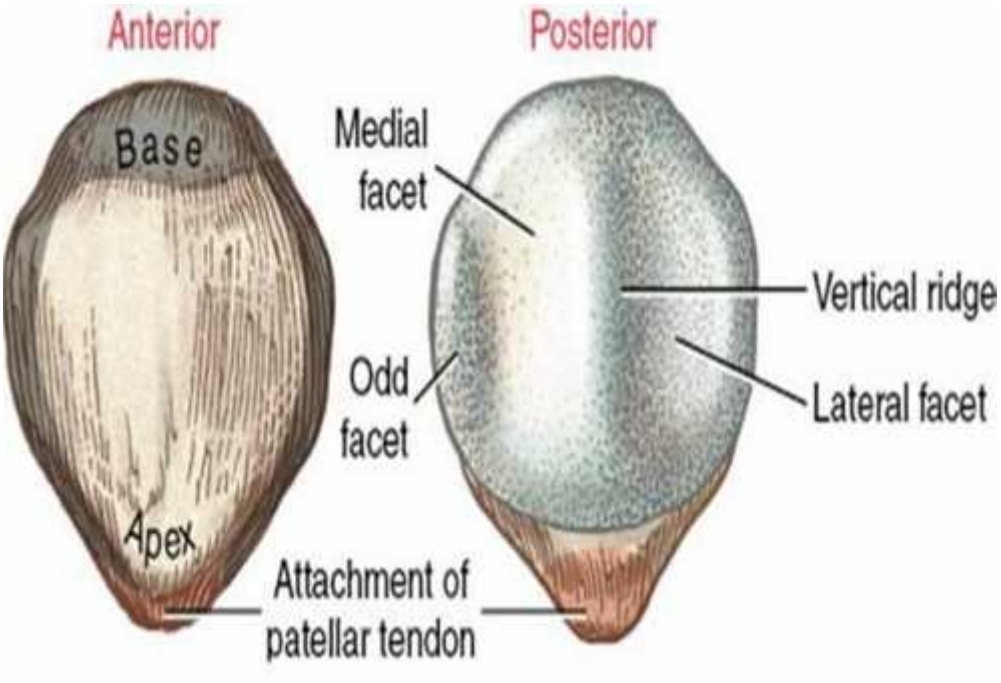


Fig. 6 Articular surface of patella(facets)

The classification of normal shape most widely quoted depends on the site of the ridge in section as depicted in the axial view, that is to say, the relationship in size between the medial and lateral facets.Wiberg defined the following types:

Type I - The facets are of equal size.

Type II - The ridge is situated towards the medial side/medial facet is small

Type III - The ridge is located markedly to the medial side/medial facet is very small.

It follows that relationship exists between the type of patella and the size of the related femoral condyle whether the shape of the patella determines future pathology is a matter controversy. In type III the so called Hunter's cap variety, lack of development of the medial aspect may reflect the status of the vastus medialis component of the quadriceps and particularly the oblique fibers and thus indicates a possible liability to subluxation or dislocation. Baumgartl described a 4^{th} type, the Jagerhut patella, characterized by absence of medial facet[24].

Structure:

The patella consists of a nearly uniform dense cancellous bone, covered by a thin compact lamina. The trabaculae immediately beneath the anterior surface are arranged parallel with it. In the rest of the bone they radiate from the articular surface towards the other parts of the bone.

Ossification:

The patella begins to ossify from several centres which appear in the third to sixth years and quickly coalesce. Accessory marginal centres appear and fuse with a central mass.

Blood Supply: [20]

Scapinelli in 1967 studied the blood supply of the human patella. He observed that six of the main arteries act as channels of blood supply to the patella and these are,

1. The superior genicular artery
2. The medial superior genicular artery
3. The lateral superior genicular artery
4. The medial inferior genicular artery
5. The lateral inferior genicular artery
6. The anterior tibial recurrent artery

The above arteries form the source of an extraosseous and an intraosseous arterial supply to the patella.

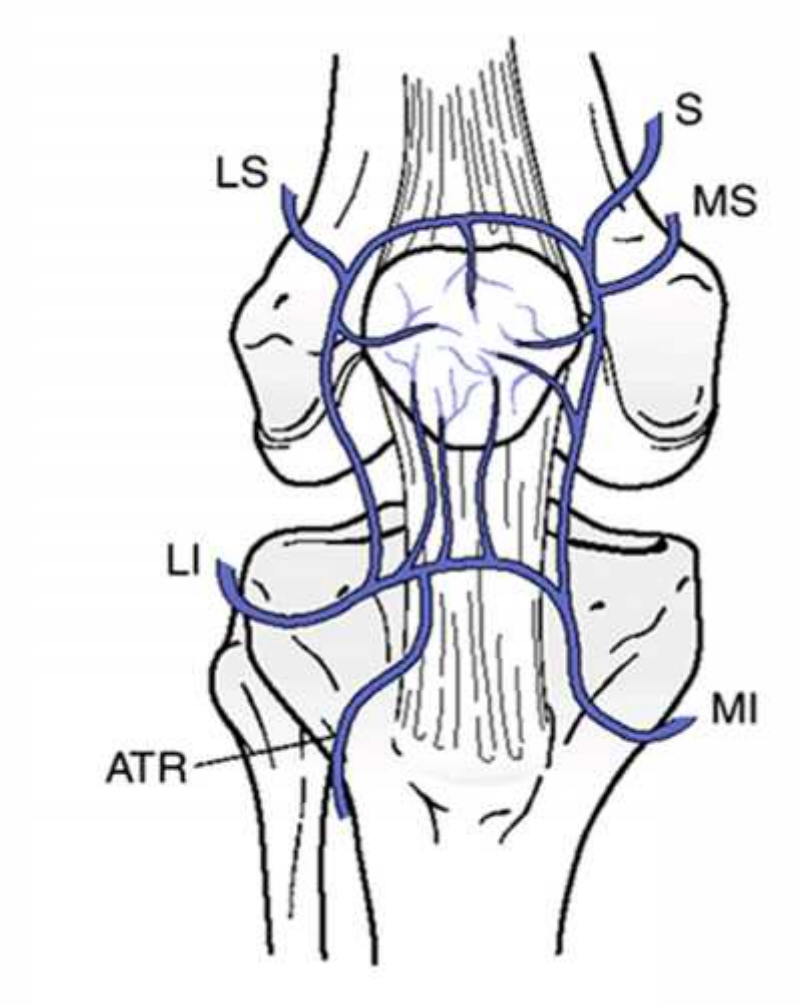


Fig. 7 Blood supply of patella

S - The superior genicular artery

MS - The medial superior genicular artery

LS - The lateral superior genicular artery

MI - The medial inferior genicular artery

LI- The lateral inferior genicular artery

ATR-The anterior tibial recurrent artery

Extraosseous or extrinsic arterial supply: [21]

The superior arteries give off descending parapatellar branches, superior transverse branches and prepatellar branches. The inferior arteries give off

ascending parapatellar branches, inferior transverse branches and prepatellar branches.

The parapatellar and transverse branches give rise to an arterial ring which surrounds the patella. The inferior part of the ring, the transverse infrapatellar artery surrounds the patella. The other parts of the ring and the prepatellar network lie in the thin layers of loose connective tissue which covers the dense fibrous extensions of the quadriceps tendon.

Intraosseous or Intrinsic arterial supply: [21]

There are two main systems of which one is represented by the mid patellar network. The arteries enter the patella through the central part of the anterior surface obliquely from below upwards and are distributed to the chondro osseous junction in the upper part of the patella. Recurrent branches run back to supply the anterior cortex.

The second system is represented by apical arteries which came from the transverse infrapatellar artery. The apical arteries pierce the deep surface of the apex of the patella between the attachment of the ligamentum patellae and the articular surface. They run upwards supplying the lowest part of the patella and comminucate within the bone with branches of the mid patellar arteries.

The Quadriceps Extension Apparatus: [22, 23]

The musculotendinous suprapatellar segment, the patellar segment and the patellar tendon, are the divisions of the quadriceps extension apparatus.

The suprapatellar segment has the combined strength of its four component muscles, which are inserted through their tendinous insertion into the base and borders of the patella. The direction of the pull on the patella is not

in a straight line along the thigh, but along the direct course to the insertion into the tibial tuberosity.

The rectus femoris muscle is inserted in the median line into the anterior border of the base of the patella by a thin layer and most of its fibers continue over the bony surface to form the infra patellar ligament. The fibrotendinous layer is attached to the rough longitudinal striae of the patella. On each side of the rectus femoris tendon, are the short common tendons of the medial and lateral vasti. These muscles are inserted mainly into the base of the patella posterior to the flattened attachment of the rectus femoris muscle and to the lateral and medial margins of the bone in its upper third. In the median line, deep to the tendon of the rectus femoris, is the vastus intermedius muscle which is inserted more posteriorly into the base of the patella.

The suprapatellar arrangement clasping the upper third of the patella is in three superimposed layer; a superficial layer formed by the tendon of rectus femoris, a middle layer consisting of the tendons of the vastii and a deep layer, made of the tendon of the vastus intermedius. The insertions of this suprapatellar complex at different levels explains the rupture of one or more of the components of the quadriceps extension apparatus in fracture of the patella.

The patella or the bony part of the quadriceps extension apparatus is a true sesamoid bone. Part of the supra patellar structures pass over it and by it to form the infra patellar ligament which fixes the patella in definite relation to the tibia.

Fibrotendinous quadriceps expansions from the inferior margins of the vastus muscles criss-cross over the anterior surface of the patella, superficial to the

patellar fibers of the rectus femoris muscle. These expansions diverge on each side, and anchor the quadriceps muscle and the patella to the enveloping fascia making for stability of the patella and reinforcing the capsule of the knee joint. These form the lateral expansions.

The normal angle between the femur and tibia renders the patella liable for lateral dislocation. This is prevented normally by two factors:

1. There is a ridge of bone over the lateral condyle.
2. The attachment of vastus medialis to the patella is along the inner margin and extends to a lower level when compared to that of vastus lateralis.

Therefore in all conditions where the knee joint is not used it is the vastus medialis that gets wasted earlier. Hence it is also called the “key of the knee joint.”

There are two accessory patellar ligaments, called the lateral and medial retinaculae. They are strong, resistant, fibrous supports, connecting the margins of the patella near its apex with the margins of the tibial condyles as far back as the collateral ligaments. Their purpose is to fix the apex of the patella to prevent dislocation, with the more expansive medial retinaculum overcomes the tendency to lateral displacement.

Function of Patella:

a) Elevating the extensor mechanism from axis of rotation of the knee joint thereby increasing the lever arm, reducing force and energy expenditure.
b) Provides cartilage on cartilage articulation which increases the efficiency of extensor apparatus to tolerate high compressive load
c) Centralizes the divergent force of quadriceps
d) Acts as a shield for the joint and protects articular cartilage of anterior femur and tibia from direct trauma
e) Can be used for taking bone graft(bone-tendon-bone graft)

The quadriceps unique among muscle groups cannot be seen in isolation. In conformation and development it is dependent not only on the existence of the patella but on its relationship to the femoral condyles. The function of the patella is to maintain the quadriceps tendon at the maximum distance from the centre of rotation of the joint. It affords an index of the degree of the erect posture and thus reaches maximum development in modern man. It follows that in order to exercise, the level at which it is located in relationship to the femoral condyles is important. It influences not only the possibilities for muscular development in general but the form taken by individual components and in particular vastus medialis. In flexion it sinks into the intercondylar notch and is in the minimal distance from the centre of rotation. It is with the increase of extension that the maximum distance is achieved depending on the profile of the condyles.

In extension the patella moves through a distance of about 2 cm from the position of relaxation to that of maximum contraction. This movement is eliminated

at 30° of flexion, and thus to determine the level of the patella in relationship of femoral condyles, a lateral radiograph in 30° of flexion is helpful in addition to one weight bearing in complete extension and with the quadriceps in maximal contraction.

Mechanism of descent: [3]

It is almost the universal complaint of patients with affections of the patello-femoral joint that they experience pain on descending stairs or inclines, and it surprises that it should occur in considerably greater degree, than during ascent. In descent it is necessary to relax the quadriceps on one side while the entire body weight is supported by the other. Immediately before the foot of the presenting limb strikes the ground, the calf muscles and quadriceps are suddenly contracted to accept the descending body weight. The forces imposed on the abnormal patello-femoral joint are considerable, greater and more sudden, than in ascent.

Ability to stop: [3]

The role of the patella in the transmission of the quadriceps and hamstring power to the femur in the act of retardation of forward motion after the manner of external contracting brake should be appreciated. It is the explanation of the inability of those who have undergone patellectomy to run and particularly take part in field games. It is not so much that they cannot run as that they cannot stop while running. The ability to decelerate rapidly is impaired.

Mechanism of Injury and Types of Fractures: [1, 23, 24]

In the past most authors divide fractures of the patella into two main types on the basis of the mechanism of injury. In general transverse fractures were believed to result from indirect trauma, whereas comminuted fractures were attributed to direct trauma. However, it is now recognized that other factors, such as the degree of knee flexion at the time of trauma, are important in determining the type of fracture produced. At 30° flexion the patella is tilted and transverse support is narrowed. Pressure exerted against the femur by the tensile forces of the quadriceps and patellar ligaments increases progressively with increasing flexion. It has been recognized that a number of different types of fracture may result from the same mode of injury.

The typical indirect fracture is transverse, with some combinations of the non articular surface. When the accelerated limb controlled by the musculo tendinous unit is stopped suddenly, patellar fractures generally result from the effect of indirect forces. The superolateral pole of the patella may actually be ruptured by uncontrolled muscular contraction during athletic activity. The type of trauma may produce a fracture with a pattern resembling the one seen in most patients with bipartite patella. After the fracture occurs, collapse of the knee against muscle tension probably accounts for tearing of the quadriceps expansion and fragment separation.

Although fractures resulting from direct trauma are typically stellate or comminuted, displaced or undisplaced fractures may also be produced by the same mechanism. A combination of trauma, muscle contraction, and joint collapse results in surface comminution and fragment separation. It should be noted that

comminuted fractures are not invariably accompanied by rupture of the quadriceps expansion, even though the patella may be severely crushed.

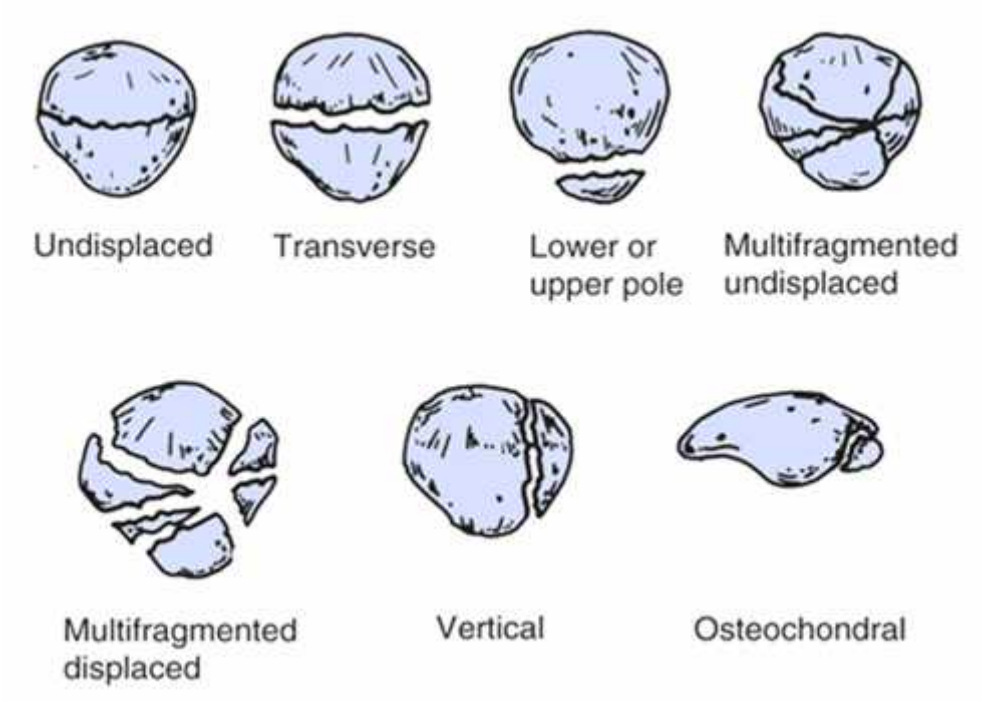


Fig. 8 Classification of patella fractures

Non-displaced

1. Transverse
2. Stellate
3. Vertical

Displaced

1. Transverse
2. Stellate
3. Multifragmented
4. Polar
5. Proximal
6. Distal
7. Osteochondral

Osteochondral fractures of the patella are rare. First reported by Kroner in 1905 [25]such fractures have been reported only sporadically since then. Widespread participation in competitive athletics by both sexes may lead to an increased incidence of these fractures. Since osteochondral fractures invariably occur on the medial aspect of the patella, lateral hypermobility of the patella is considered a prerequisite for their production. While these fractures are not easily detected on conventional X-rays and are difficult to identify with clinical signs referable to the fracture's medial margin. Arthrography and arthoscopic evaluation should enable earlier and more accurate diagnosis.

Clinical features: [15]

Fractures of the patella constitute approximately one percent of all skeletal injuries. Injuries resulting from road traffic accidents increase the number of these fractures.

The fracture may be seen in all age groups but is not common below the age of 20 years. Both sexes are prone to injury. In most of the series male predominance was observed. In Bostrom series, 57% were males and 43% females, the mean age being 42 and 54 years respectively. The maximum frequency for males was reached between the ages of 30 and 39 years and for females between 60 and 69 years.

The most common mode of injury is fall in the same plane and next common are various types of traffic accidents.

Signs and symptoms:

The patient always complains of pain in the affected knee joint. In the case of a transverse fracture there is loss of active extension although passive extension is still possible, it is very painful. The joint is distended by haemarthrosis which

when aspirated yields frank blood with floating fat globules. If the fragments are widely separated a defect may be palpable.

A typical finding in the patients inability to lift the leg with the knee extended and the patient being unable to stand on the affected limb. However, in fractures in which the quadriceps mechanism is intact the diagnosis may be more difficult. . These include longitudinal and marginal fractures as well as fractures of the distal non-articular pole.

Investigations:

Apart from the routine blood and urine examination to know the general condition of the patient, X-ray of the knee is taken both Antero-Posterior and Lateral views are taken routinely. However a Roentgenographic study is incomplete unless it included oblique views and the axial or "sun rise" view to rule out or define longitudinal and marginal fractures.

Diagnosis:

The diagnosis of a fresh patella fracture usually involves no difficulties. The correct diagnosis is readily established from the history, clinical manifestations and X-ray examinations.

Differential diagnosis:

A fracture of the patella must be differentiated from a congenital bipartite or tripartite patella. It should be noted that the typical site of the marginal fracture differs from the location of the accessory ossification centre in bipartite patella. In the latter condition which is a normal variant a line similar to that seen in fractures runs obliquely over the superolateral margin of the patella. In addition bipartite patella is frequently bilateral and symmetrical.

Fractures of the patella also have to be differentiated from Larsen-Johanson disease, or osteochondritis of the poles of the patella. This disease occurs in adolescents, usually boys, between 10 and 14 years of age. Pain and soft tissue swelling and tenderness are noted over the lower pole, less commonly upper pole. It causes a limp and inability to kneel and run. Extension of the knee against resistance accentuates the pain.

The principle of the tension band

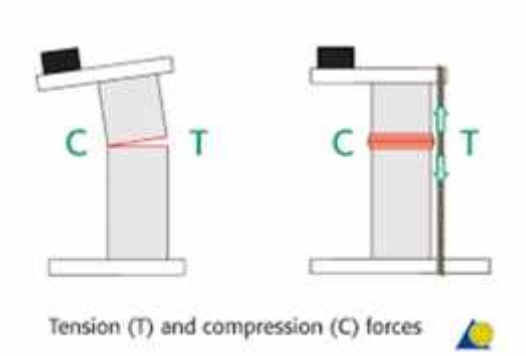


Fig. 9 Principle of Tension Band

Pauwels borrowed from mechanics the principle of tension band and demonstrated its application in internal fixation of bone. Every eccentrically loaded bone is subjected to bending stresses. This results in a typical distribution of stresses with tension on the convex and compression on the concave side of bone. This is also why when such a bone fractures it displaces with a gap on the tension side. In order to restore the load bearing capacity of an eccentrically loaded fractured bone, the tensile forces have to be absorbed by a tension band wire and the bone itself has to be able to withstand axial compression. The tension band results in dynamic compression. It can be employed in those cases where it absorbs all the tensile forces and where the bending and shearing forces are overcome by the friction and impaction of fragments or by a supplementary Kirschner wire fixation which serves as internal splinting.

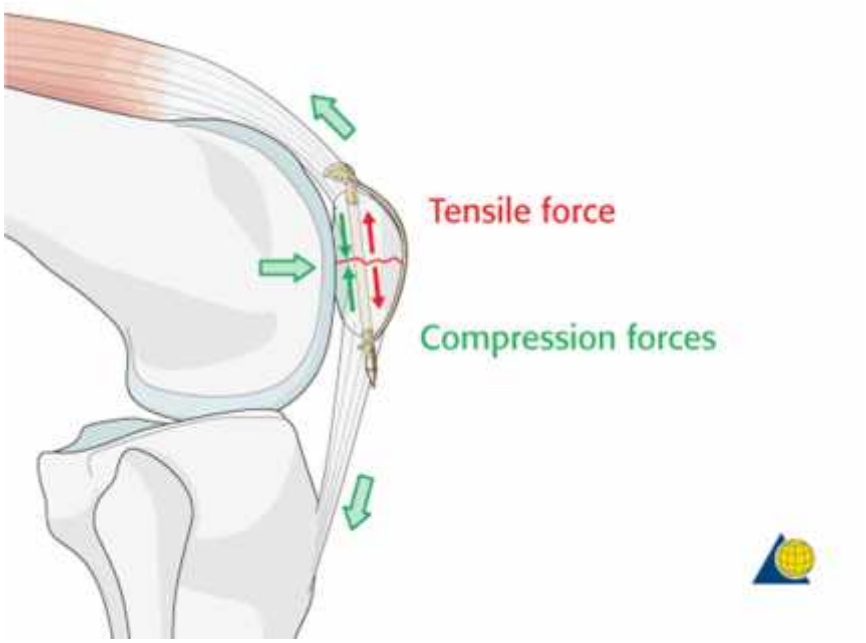


Fig. 10 Tension band principle application in patella fractures

An excellent example of dynamic compression is the transverse fracture of the patella. If a wire passed over the front of the patella and around the quadriceps and infrapatellar tendon is tightened it will result in compression of the cortex adjacent to the wire. The opposite cortex will gape slightly, but will, however come under compression when the knee is flexed and quadriceps is contracted.

Management [16, 26]

Opinion differs widely as to the proper treatment of a fractured patella. A revolutionary idea was presented by Brooke in 1937.[27] He suggested that the patella is inherited phylogenetically and is not a functional organ. He stated that although the patella is a sesamoid bone, there is no evidence that it developed in the quadriceps tendon in response to function, but rather the extensor mechanism is more efficient if the patella is excised. More recently, however, Haxton in 1945 and Kaufer in 1971 have made complete studies that refute these claims. They studied the comparative anatomy, human embryology, human anatomy and

experimental anatomy of the patella and the biomechanical aspects and clinical results of patellectomy. Haxton stated that anyone who has removed the patella can certify that the patella actually gives attachment to most of the fibers of the quadriceps and patellar tendon and that the bone transmits tension produced by the quadriceps. In experimental studies of patients with and without patellae he demonstrated that the power of extension of the knee increases as the joint extends, in other words the power of extension is greater with the knee at 30° flexion, than at 60°, 90° or 120°. Since extension is the most important function of the knee, it must be quadriceps mechanism, but this may not be enough to interfere with ordinary activities.

After patellectomy the effective radius of the patella-quadriceps pull from the centre of rotation of the knee is shortened, there by requiring more quadriceps force to accomplish the same degree of powerful knee extension. The presence of the patella increases the radius from the centre of rotation of the knee, thereby increasing the mechanical advantage of the patella-quadriceps mechanism and making knee extension more efficient. There are other objections regarding patellectomy for all fractures of the patella.

1. The strength of the quadriceps mechanism returns. Slowly although motion in the knee may be regained fairly rapidly.
2. Obvious atrophy of the quadriceps muscle persists for months and often permanently after patellectomy despite exercises.
3. The protection of the knee by the patella is lost.
4. Pathologic ossification may develop where the patella was excised.

Whatever method of treatment is selected as most suitable to the individual problem, it is important especially in the event of operation, that it

should be initiated immediately. It is the common experience that earlier the operation is performed more rapid the recovery and better the end result in terms of return of extension.

Principles of management of fracture patella: [28]

1. Restoration of fracture fragments or excision of patella either partially or totally with repair of quadriceps expansion.
2. Rest to the part till healing of quadriceps expansion or healing of fracture, in particular when total patellectomy is done.
3. Restoration of quadriceps power and knee function.

Conservative treatment:[29]

Indications:

1. Fracture by indirect violence in which the injury takes the form of nothing more than a transverse fissure; there is no displacement of fragment and no injury to capsular (retinacular) expansion.
2. Injuries by direct violence in which the fracture takes the form of radiating fissures but without appreciable displacement, over riding or step formation.
3. Cases in which there are contra-indications to anaesthesia or to operation of any form. It should be recognized that in 1 and 2 above non operative treatment entails immobilization in a plaster cast above knee until union is complete. This may hold no advantage over operation and internal fixation permitting early active weight bearing movement.

Technique:

Effusion of blood into the joint is evacuated through a wide bore needle under local anaesthesia with aseptic precautions. There after a compression bandage is applied, supplemented by above knee posterior plaster slabs.

When the swelling has subsided and the normal contour of the joint restored a walking plaster of the type which does not immobilize the ankle joint(cylinder cast) is applied. It is important to secure the maximum immobilization of the patella by moulding the plaster around the superior, medial and lateral margins.

The plaster of paris walking cast should be reapplied if it is loose due to further subsidence of swelling.

The plaster cast is retained for 4 to 6 weeks, thereafter more vigorous quadriceps exercises and knee flexing exercises are commenced.

Operative Treatment:[30]

Indications:

1. Fractures in which there is more than 3mm fragment separation.
2. Fractures with articular incongruity of more than 2mm. Methods of treatment in common use are :

- Restoration of normal anatomy of fractured fragments by using metallic implants.
- Repair of quadriceps apparatus retaining one large fragment (partial patellectomy).

Open reduction and internal fixation:

Once reduction of the articular surface is achieved it is accompanied by internal fixation which may be carried out in several ways:

1. Circumferential wire loop fixation.
2. Inter-fragmentary wiring.
3. Screws or pins.
4. Screws or pins in combination with wiring.
5. Tension band wiring technique used by the AO group.

When the skin is normal, the operation should be done as soon as possible. In abrasions or laceration earliest wound toilet and thorough debridement are of paramount importance in prevention of infection. Once lacerations or abrasions become superficially infected, surgery must be delayed till the wound heals.

Common approach and technique for patellar fractures: [31,32]

A transverse curved incision approximately 12-15 cms long with the apex of the curve on the distal fragment will give enough exposure for reduction of the fracture and repair of the ruptured extensor expansion and capsule. If an area of skin is severely contused, attempt to avoid it or elect to excise a small area, since skin closure produces no significant difficulty. Reflect the skin subcutaneous tissues proximally and distally to expose the entire anterior surface of the patella, the quadriceps and patellar tendons. If the fracture fragments are significantly separated, tears in the extensor expansions are presumed, and these must be carefully explored medially and laterally. Remove all detached fragments of bone and inspect the interior of the joint and especially the patellofemoral groove for an osteochondral fracture or damage to the articular cartilage. Thoroughly irrigate the interior of the joint remove blood clots and small pieces of bone. Anatomically reduce the fracture fragments using the patella holding forceps and fix the fragments internally. Inspect and palpate

the articular surface after fixation to be sure that the reduction is anatomical. Careful repair with interrupted sutures the ruptured capsule and extensor mechanism from their outer ends towards the midline of the joint.

1. Circumferential wire loop fixation:

Circumferential wire loop fixation has probably been the most popular technique in the past decade. It has largely been replaced by more rigid fixation techniques to permit early motion of the joint with the loop threaded through the soft tissues about the patella, rigid fixation is not achieved, so a delay of 3 to 4 weeks in starting knee motion is necessary if this technique is used.

Technique (Martin):

Begin threading a No. 18 stainless steel wire at the superolateral border of the patella, passing it transversely immediately next to the superior pole of the patella through the quadriceps tendon. Pass the wire through the tissue using a large Gallie needle and thread it through a large Intracath needle, inserted with the sharp point exiting at the site where the next suture is desired. Fit the No. 18 wire into the sharp end of the intracath needle, and as the needle is withdrawn, pass the No. 18 wire along its path within the needle. Pass the medial end of the wire in a similar manner along the medial border of both fragments midway between the anterior and posterior surfaces. Next pass the medial end of the wire transversely through the patellar tendon from the medial to the lateral side around the distal border of the patella and then proximally along the lateral side of the patella to the superolateral border.

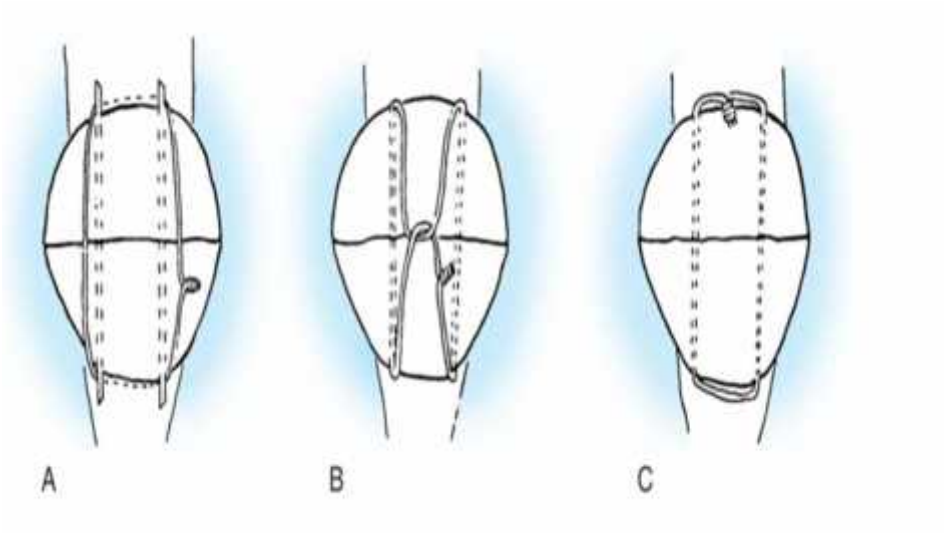


Fig. 51-70 Types of patellar fixation. **A,** Modified tension band. **B,** Lotke longitudinal anterior band (LAB) wiring. **C,** Magnusson wiring.

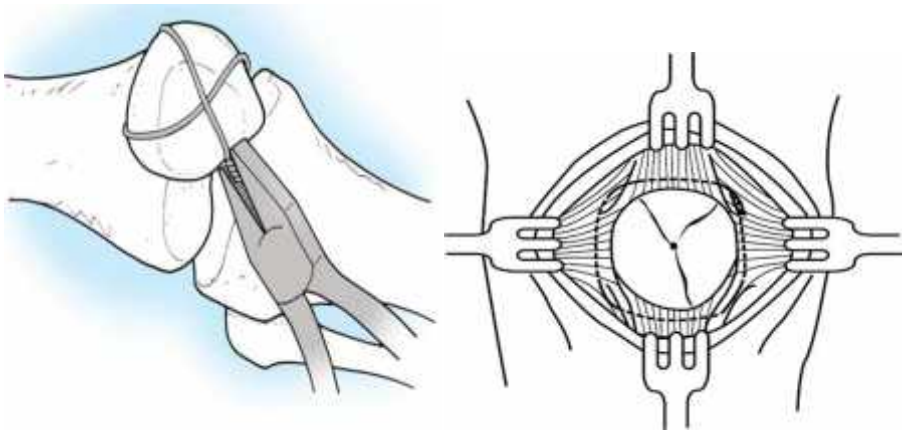


Fig. 11 Types of patellar fracture fixation

The wire must be placed close to the patella, particularly above and below; if it is inserted through tendons away from fragments, fixation will be insecure because the wire will cut through the soft tissues when under tension and allow separation of the fragments. Furthermore, centering the wire midway between the anterior and posterior surfaces will keep the fracture line from opening anteriorly or posteriorly as the circumferential wire is tightened. Approximate the fragments and hold them in position with a patella reduction forceps, then draw both ends of the wire until they are tight and twist them together. Confirm

the position of the fragments especially the relationship of the articular portion of the fragments especially the relationship of the articular surfaces by X-ray films and by direct inspection and palpation before it is repaired. Then cut off the redundant wire, depress the twisted ends into the quadriceps tendon.

A pretwisted wire that is tightened by twists at two points opposite each other supplies more even pressure and fixation across the fracture site. Placing the first twist in the wire prior to beginning its insertion allows for this extra site for tightening.

2. Wire loop fixation through both fragments:

Technique (Magnusson):

With a small caliber drill make two holes through the proximal fragment, beginning at the medial and lateral borders of the quadriceps tendon and directed obliquely downward to open on the fracture surface of the patella posterior to a point midway between anterior and posterior surfaces.

Drill two corresponding holes in the distal fragment, their apertures being opposite to those of the proximal fragment. Then thread a No. 18 wire distally through the medial holes and then proximally through the lateral holes. After properly opposing the fragments draw the ends of the wire taut and twist them together. Cut off the extra wire and embed the twisted ends in the soft tissue.

Supplementing internal fixation using threaded pins or lag screws that produce interfragmentary compression across the fracture site are specially useful.

3. Tension Band wiring for fixation:[33]

The AO group in Switzerland has used and recommended a tension band wiring principle for fixation of fractures of the patella. By proper placement of wires the distracting or shear forces tending to separate the fragments are converted into compressive forces across the fracture site, resulting in earlier union and allowing immediate motion and exercise of the knee. Generally two sets of wire are used, one in a conventional circumferential manner and the second passed transversely through the insertion of the quadriceps tendon immediately adjacent to the bone of the superior pole, then passing anteriorly over the superficial surface of the patellar tendon to the anterior aspect, or the tension surface of the patella in a figure of eight manner. The capsular tears are then repaired in the usual manner. The knee is immobilized in flexion, and early active motion produces compressive forces to keep the edges of the articular surface of the patella compressed together. Early active flexion exercises are essential for the tension band principle to work.

Shauwecker describes a similar technique but crosses the wire in a figure of eight over the anterior surface of the patella. Again supplemental lag screws or Kirshner wires may be used to increase fixation in comminuted fractures.

4. Modified tension band wiring :

After exposure of the fracture fragments, the fracture is cleared of all clots and debris. The knee joint is inspected for loose fragments and intraarticular damage to the cartilage. The knee should be slightly flexed or extended to assist in the reduction of the articular surface.

The fracture is reduced and held with reduction clamps, and the articular surface is evaluated for any malreduction. Two 2 mm Kirschner wires are used to maintain the reduction, provide rotational control, and maintain anchorage of the cerclage wire. The K-wires can be placed in an antegrade or retrograde fashion. A 2-mm drill bit can be passed from superior to inferior, starting 5 mm from the anterior cortical surface of the patella at a line separating the patella into thirds.

The retrograde technique requires the reduced fragment to be taken down and the proximal fragment flexed to expose the fractured surface and a 2-mm bit passed in a distal to proximal manner, with the exit the same as the starting point for the antegrade technique. The bit is exchanged for a 2 mm K-wire.

The procedure is repeated, placing a second K-wire parallel to the first. The fracture is then reduced and held with reduction forceps. The K-wires are removed and holes are drilled in the distal fragment with a 2.0-mm drillbit into the distal fragment. The drillbits are replaced with the K-wires. A modification of the technique is to use sharp K-wires and pass the sharp end into the distal fragment once the reduction is achieved. The K-wires serve to anchor the tension band and neutralize the rotational forces.

An 18-gauge wire is passed encircling the patella. The arms of the wires are crossed over the anterior surface of the patella in a figure-of-eight fashion or figure-of-zero. The fracture reduction is checked to ensure that the articular surface is adequate by visual or digital palpation through the tear or through an arthrotomy in the retinaculum. If the reduction is satisfactory, a wire twister should be used to slowly tension the wire. The medial and lateral limbs of the figure-of-eight wires are sequentially tightened to apply tension equally across

the fracture site, giving even compression across the construct. Unilateral tightening may cause asymmetric compression and not reduce the excess slack in the other arm of the loop. Care must be taken not to overtighten the wires, which can lead to malreduction or further comminution of the fracture pattern. The ends of the parallel wires are cut and turned 180 degrees over the tension band loop, and the superior and inferior ends are buried in the bone to prevent migration.

Advantages of open reduction and internal fixation: [33]

1. It restores the functional integrity of bone.
2. It restores the protective mechanism that is necessary for a normal knee.
3. The symmetry of knee joint is maintained.
4. The period of immobilization is reduced to the minimum.
5. The residual disability is minimal.

Disadvantages of open reduction and internal fixation: [33]

1. There is often difficulty in restoring a smooth articular surface and some degree of roughening may occur which predisposes to early osteroarthritis.[14]
2. Comminution of fragments will not allow proper reduction.
3. The use of metal screws and wires for fixation near a joint is likely to cause reaction.
4. Circumferential repair is detrimental because it may strangulate the nutrient vessels resulting in avascular necorsis.
5. Separation of fragments may occur inspite of fixation due to the continuous distraction forces of the quadriceps which is largely responsible for the occurrence of fibrous union.
6. It may sometimes be difficult to remove the implant.

Partial Patellectomy: [34, 36]

When either proximal or distal pole is fractured and comminuted, the fragments may be excised and the quadriceps mechanism repaired.

In comminuted patellar fractures, often only the distal pole of the patella is fragmented leaving a substantial and relatively normal proximal fragment. This fragment is an important part of the extensor mechanism and should be preserved. The possibility that it may later produce patellofemoral arthritis has been emphasized too much. The detail of sutures of the patellar tendon to the fragment should be observed carefully to avoid a tilt of the fragment so that its sharp edges will not erode the patellar groove.

Technique:

Expose the fracture through a transverse incision and clear the joint of any loose fragments of bone and cartilage. If the proximal half or more of the patella is intact, trim away the edges of the capsule and tendon. Excise the comminuted fragments, leaving a small fragment of the distal and anterior part of the patella buried deep within the tendon facilitate anchorage. Trim the articular edge of the proximal fragment and smoothen it with a rasp. Now, beginning on the fracture surface of the proximal direction. Using a wire passer, pass a 18G stainless steel wire through the patellar tendon distal to the small fragment of bone and then insert its ends through the holes in the remaining part of the patella. Draw the wire tight, so that the small fragment of bone in the patellar tendon is evaginated and lies in an axis at right angle to its original position and oppose the fracture surface, if the wire suture is placed correctly in a posterior position through the fracture surface, the patellar tendon will come in contact principally with the articular edge of the fragment and not its anterior edge, thus

the tilt of the fragment is prevented and its raw surface does not contact the femur. If preferred, place a circumferential wire loop around the proximal fragment instead of passing the wire through the two holes as described.

Occasionally the proximal pole of the patella is comminuted, leaving a single distal fragment consisting of half or more of the bone. This fragment, provided it contains a smooth articular surface, should also be preserved by applying the principles given in the technique just described.

Total excision of patella (Patellectomy): [35, 36, 37]

Indications:

1. In grossly comminuted fractures in which there is no suitable fragment to which the opposing tendon can be anchored.
2. In compound fractures.
3. In old un-united or mal-united complicated by traumatic patella femoral arthritis.

Technique:

A curved incision or an anteromedial incision may be used for patellectomy. The skin and subcutaneous tissue are retracted. Each fragment is held by a towel clip and removed by sharp dissection. Place a No. 18 stainless steel wire through the medial and lateral capsular extensor expansions in a purse string manner. Tighten the wire and evaginate the tendons completely outside the joint. Twist the wire, cut it off at the twist and embed the ends in the quadriceps tendon. This rosette of tendons may give the appearance of a small patella. Supplemental interrupted sutures are used to repair the capsular rupture and to further appose the quadriceps and patellar tendon ends. The purse string

shortens the quadriceps mechanism and helps prevent extensor lag which is common after a patellectomy

Rest to the part till healing of quadriceps expansion or healing of fracture:

A posterior P.O.P. slab from groin to ankle is applied which provides sufficient immobilization during the early post operative period. The patient is encouraged to perform quadriceps setting exercises and within a few days should be lifting, the leg off the bed. On the 10^{th} day the sutures are removed and a cylinder cast is applied with the knee in extension. The patient is allowed to be ambulatory when active muscles control of the leg has been obtained. After 3 weeks the immobilization can be removed and active assisted exercises begun.

In patients treated by modified tension band wiring isometric quadriceps exercises are begun as soon as pain decreases in intensity which helps in healing of fractures and prevents quadriceps wasting.

Restoration of quadriceps power and normal knee Function:

Quadriceps exercises:

Watson-Jones emphasized the utmost importance of the quadriceps exercises in the treatment of all knee joint injuries. He has written "Redevelop the quadriceps: exercise for five minutes hourly throughout the day". Almost every type of injury of the knee should be treated from the first day by regular quadriceps drill. Muscle wasting occurs as a direct consequence of injury of the knee joint. An almost total reflex inhibition of the quadriceps may be observed and the muscle is completely flaccid, for no sign of active contraction seems possible. Wasting is rapid and volume of the muscle disappears more rapidly than it can be regained. Therefore treatment is urgent. The inhibition must be overcome as soon as possible by the patient's own exercises. Quadriceps

contraction must be demonstrated. The muscle should be made as tight as possible and the contraction sustained. The following exercises should be advised.

Rhythmical quadriceps drill, quadriceps setting or isometric contractions:

This is a simple measure of wide application and is of the utmost value at all stages of recovery. It consists of three phases:

a) Contraction

b) Contractions sustained

c) Relaxation.

The surgeon should demonstrate the exercise with his own leg and ask the patient to perform it.

Straight leg raising:

This is the simplest natural exercise which the quadriceps can perform. It has the important advantage, that the patient is merely required to raise his own leg from the bed and is not asked to learn anything strange. It also can be assisted. When the patient cannot be persuaded to raise his leg from the bed, a method, almost invariably successful in initiating contraction is to turn the patient prone, tell him to dig his flexed toes into the mattress and then raise his knee from the bed.

Loaded straight leg raising:

At a later stage in recovery following injury or the application of plaster cast, loading is achieved by the addition of weights, ranging from 1 to 4 kg. Attached to the ankle and used in sequence as the muscle shows evidence of progressive improvement.

Simple resisted exercises:

After removal of the cast active movements of the knee can be started.Following this, resisted exercises should be performed. Sitting on a heavy table with a folded towel under the thigh and weight attached to the foot.

Advanced resisted exercises:

In the design of apparatus for resisted exercises applicable to the later stages of recovery, it is desirable, in view of the relationship between the vastus medialis and the final phase of extension, that the heaviest load be imposed as the joint approaches full extension. The common pulley weight apparatus in use does not fulfill this requirement but does the reverse. Delorme (1945) points out that the difficulty can be overcome by attaching the weight directly to the foot. In these circumstances there is practically no resistance at the starting point but as the knee extends, it rapidly increases to attain the maximum when the joint fully extended.

Delorme's method using an iron shoe fitted with a bar to which is attached iron plates graded from 0.5 to 12kgs differs essentially from loaded straight-leg raising in utilizing resistance through 90° of motion in the joint. The use of resistance on these lines has many advantages in the late stages of rehabilitation.

Recently Smile modified Moncur's design for graduated resistance exercises. The apparatus consists of a stainless steel tube of 20mm diameter 50cm long with holes bored from side to side at intervals of 3cms. It is hinged at the upper end to a bracket and bolted to a heavy seat. At the distal end is a strap and steel ring to which is attached an adjustable loop into which the patient places his foot. The variable load weighing 12 kgs is welded to the bar, a collar 5cms in

length and of a diameter which slides over the tube. Adjustments of the load in units of 0.9 kg are made by locating the site by means of a pin. The apparatus is simple, easily adjusted, virtually silent and cannot impose an undesirable passive traction or torsion strain on the relaxed joint in the early stages of recovery from injury or operation.

Complications and their Management

Complications in cases of fracture of the patella may develop when they are left without any treatment or after they have been treated.

1. Non-union of the fracture fragments:

As patella is a sesmoid bone repair has to take place from the fractured surfaces by a process known as creeping substitution as there is no periosteum. Therefore if fragments are not in opposition, non-union is unavoidable. Marginal or polar fractures rarely go for union as vascular patella fracture may go for fibrous union and may result in quadriceps weakness. Therefore in such a situation operative exploration and freshening of fragments and approximation would be ideal. In long standing cases of non-union, the patella may have to be excised and the gap closed.

2. Loss of Quadriceps Extension Power:

The loss of quadriceps extensor power constitutes a serious disability. Weakness leads to instability of the knee, a limping gait and pain. Regular quadriceps exercises and active movement helps to regain the loss of quadriceps extensor power.

3. Osteoarthrtis of Patello-Femoral Compartment:

In the middle aged and elderly patients, a comminuted fracture is bound to go for patello-femoral arthritis which in turn may lead to osteoarthritis of the knee later. This complication is best avoided by excision of the patella.

Wire sometimes used to encircle the patella or passed through drill holes in the fragments occasionally snaps where the ends are twisted together or because the metal is too soft or is dissolved by ionization. The wire may get fragmented and separated in to the joint as foreign body.

4. Avascular necrosis :

Fracture of the patella is not an exception as far as avascular necrosis is concerned. Usually the upper fragment or infrequently an intermediate fragment goes for avascular necrosis. Radiological evidence can be expected only after one or two months after the fracture, characterized by an increase in the density of the affected fragment. The pathology of avascular necrosis was first reported by Watson-Jones in a case of transverse fracture fixed with a screw.

5. Mal-union:

Mal-union in patellar fractures can occur when it is of the comminuted, stellate type. A mal-union results in irregularity of the articular surfaces leading to chronic pain, limitation of movement and patello-femoral osteoarthritis. Treatment is patellectomy.

MATERIALS AND METHODS

The present study consists of 30 selected cases of fractured patella treated by modified tension band wiring at the Shri B M Patil Medical College Hospital and Research Centre, Vijayapur. from December 2014 to March 2016.

The details of the cases were recorded as follows:

The name, age sex, occupation, address, family history and past history were noted. The history was elicited from the patients. The nature of trauma, whether due to direct or indirect violence was noted. Whether trauma due to Road traffic accidents, assault, fall in the same plane or fall from a height were specifically asked. Enquiry was made to note pain, swelling its rate of increase and if the patient was able to bear weight on the affected limb and was able to do active movements of the affected joint.

General condition was examined as to his build. Nutritional status, the condition of respiratory and cardio-vascular systems and for associated injuries.

Local examination was done in the following steps*:*

On inspection the following points were noted. Whether the knee was swollen, if so the size, shape and extent of the swelling, condition of the skin over the swelling and presence of any contusion, abrasion or laceration. Whether any sulcus present in the middle of the swelling.

1. On palpation the following points were noted. Any local rise of temperature, tenderness over the bone a palpable transverse defect or sulcus, crepitus, fluctuation and broadening of patella.
2. Active extension movements of the affected knee noted compared with normal side. It was also noted whether the patient was able to stand on his injured limb.

3. The circumference of both the thighs were measured to note any reduction in the bulk of the quadriceps.
4. The other knee joint was examined for comparison and to note any anatomical variation.

Investigations:

Routine examination of blood and urine were done for haemoglobin percentage, total and differential WBC count, bleeding and clotting time and presence of albumin and sugar in urine and HbsAg, HIV and HCV tests.

X-ray Examination:

X-rays in lateral and antero-posterior views were taken for confirmation of diagnosis. X-rays in skyline view were taken in cases suspected to have longitudinal and marginal fractures.

Treatment:

After the X-rays the limb was immobilized by an above knee POP posterior slab. Operations were done at a later date. If abrasions were present in the skin they were cleaned, dressed and antibiotics given. Patients were prepared for surgery during this period. On the day before the surgery the part was prepared and antibiotics started. Patients were taught static quadriceps drill and straight leg raising exercises.

OPERATIVE PROCEDURE

Fig. 12 INSTRUMENTS

Fig. 13 PAINTING AND DRAPING

Fig. 14 SKIN INCISION

Fig. 15 EXPOSURE OF FRACTURE FRAGMENTS

Fig. 16 FRACTURE REDUCTION AND K-WIRE FIXATION

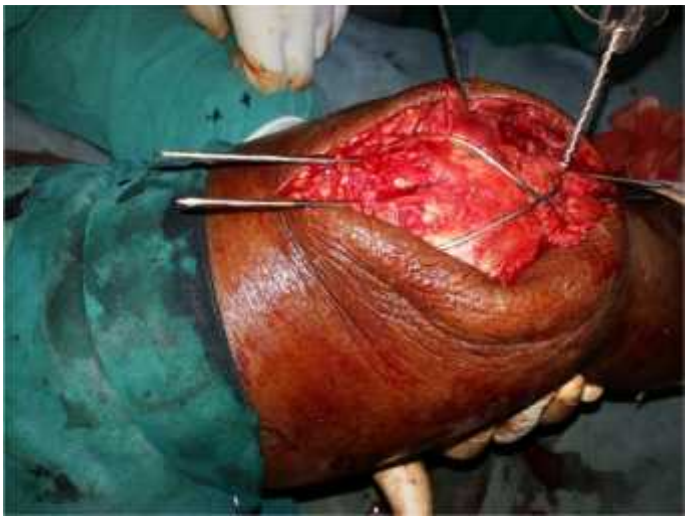


Fig. 17 CERCLAGE WIRING

Fig. 18 SKIN CLOSURE

Fig. 19 INTRA OPERATIVE IMAGE

Technique of operation:

Operative Procedure

The operation was performed under spinal anaesthesia. Tourniquet was applied to the upper part of the thigh and the part was painted with iodine and spirit and draped. A vertical lazy 'S' incision was put over the anterior aspect of the knee. The skin and fascia were retracted to expose the fracture site. The knee was flexed to 20 and positioned on a roll. The fracture surface was cleaned of all blood clots. The extent of retinacular tears was explored and the joint inspected for any damage to the femur. The joint was then thoroughly lavaged.

About 5mm from the anterior surface of the patella, one hole is drilled with a 2 mm drill bit, from the fracture surface. A 1.5 mm K wire is inserted in the first hole and is used as a guide to drill the second hole parallel to the first. To ease drilling the proximal fragment is held with reduction clamps and the fragment tipped so that the fracture surface faces the surgeon.

Now the fracture is reduced with reduction clamps. The accuracy of the reduction is checked by inspecting and palpating the anterior and posterior surface in case of retinacular tear. Now the K wires are removed and two holes are drilled into the distal fragment from the proximal fragment. The drill bit is removed and replaced with 1.5 mm K wires which are hooked at the tip. A 20 gauge wire is passed around the K wire in a figure of 8 pattern so that the knot comes to lie next to the proximal end of the lateral K wire. This facilitates future metal removal. The wire is then tightened with the A.O tightener. After tightening the wire the tightener is tipped 90° and cut about 1 cm long and the cut end burried in the soft tissues.

The K wires are adjusted so that the curved ends face backwards, pulled down and hammered into bone. The distal portions are cut off about 1 cm from

where they exit from bone. The joint capsule and quadriceps retinaculae are meticulously repaired and the fascia repaired with plain sutures. The skin is closed with interrupted mattress sutures and a compression bandage given.

Post-operative management:

The patient is adviced to do quadriceps exercises from the first post operative day onwards and is allowed full weight bearing from the 3rd day after removal of the compression bandage. Later knee flexion was started with the quadriceps board, and continued with the continuous passive motion machine. The patients were then taught dynamic quadriceps exercises which they could do themselves at home, advised to do them regularly and discharged on the 14th day.

Follow up:

The patients on discharge were advised to report for follow up after 1 month in the first instance and then after every 2 months for 6 months.

During each follow up patients were questioned about subjective complaints like pain, difficulty in walking, squatting, climbing and stepping down stairs and inability to perform normal work.

For objective assessments patients were examined for:

1. Extension lag
2. Range of knee motion
3. Circumference of thigh
4. Efficiency of the quadriceps
5. X-ray examination of knee joint.

OBSERVATION AND RESULTS

Since the advent of surgical treatment of the fracture patella, opinion has changed from one advocating removal of the patella to on preserving either part or preferably whole of the patella. If the fragments can be realigned and fixed in such a way that once it heals, it is in no way different from its pre-fractured status, it would be the ideal treatment. In this series 30 cases of fractured patella were treated in patients between the age group of 20-50 years by the modified tension band wiring technique, special attention was given to mobilize the knee early as it helps to regain the quadriceps power.

Table-1:Age incidence

Age in years	Number of cases	Percentage
20-30	6	20
31-40	15	50
41-50	9	30

Fracture patella can occur at any age. But the frequency in children and adolescents under 20 years of age is low. In this series the range of age was taken between 20 to 45 years. The mean age was 40 years and maximum incidence was between 31 to 40 years.

Fig-20: Bar graph showing age incidence

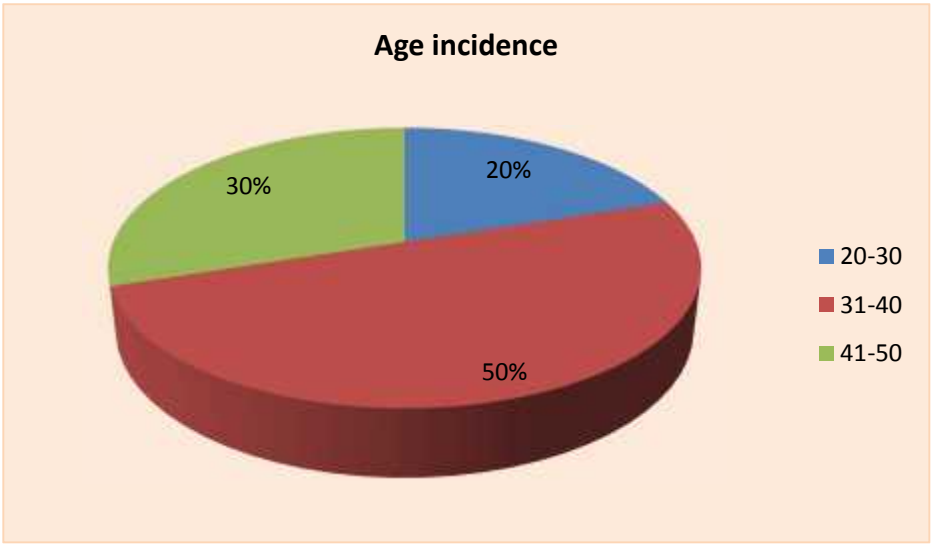


Table-2: Sex incidence

Sex	Number of cases	Percentage
Male	18	60
Female	12	40

In the present series 18 patients (60%) were males and 12 (40%) were females. In this series male sex predisposition was observed.

Fig-21: Pie chart showing Sex incidence

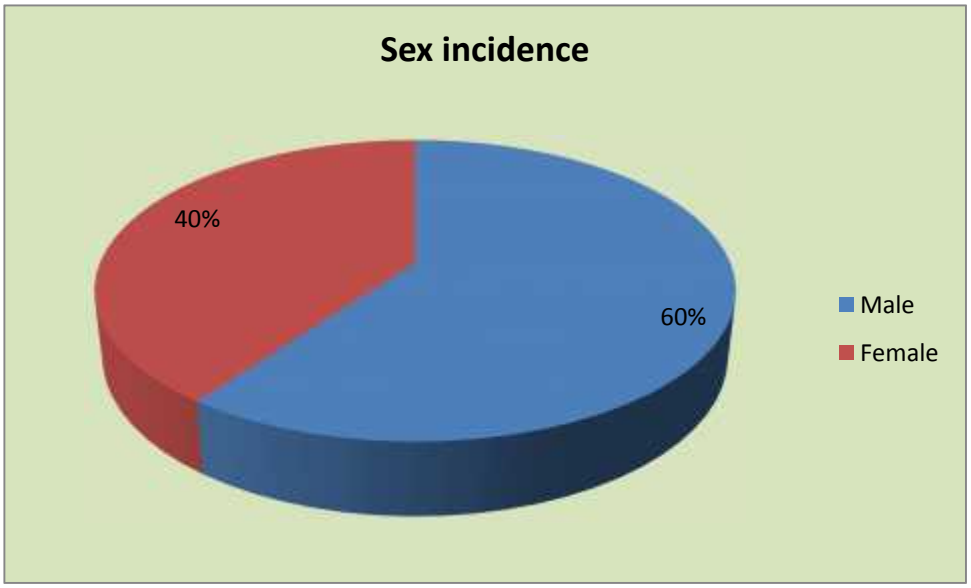


Table-3:Nature of trauma

Nature of trauma	Number of cases	Percentage
Fall in the same plane	18	60
Road traffic accident	9	30
Assault with stick	3	10

In this series 12 cases were due to direct injury and 18 cases due to indirect injury. Fall in the same plane was the most common 60%, assault with sticks directly over the patella 10% and road traffic accident 30%.

Fig-22: Graph showing nature of trauma

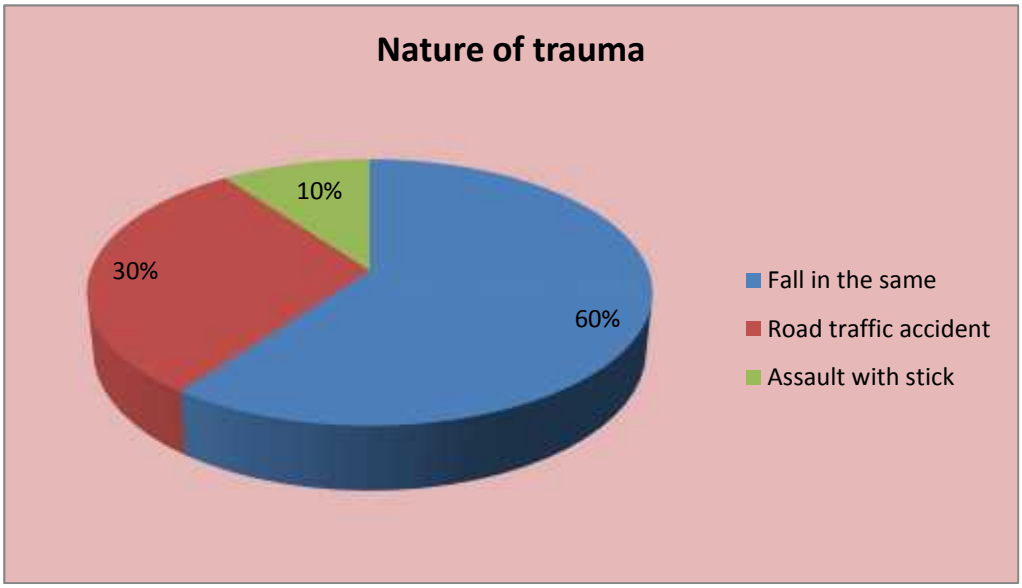
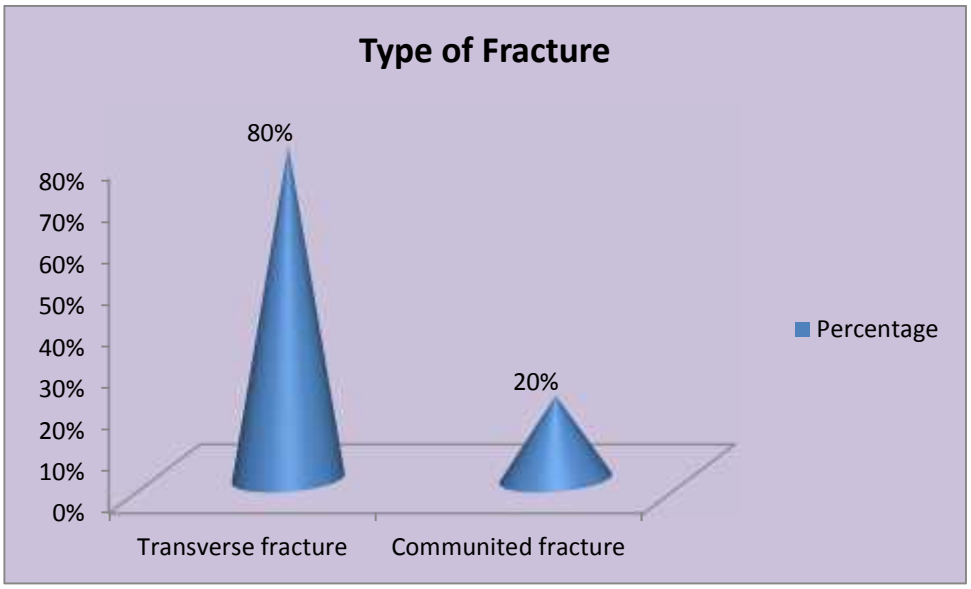


Table-4: Type of Fracture

Type of fracture	Number of cases	Percentage
Transverse fracture	24	80
Communited fracture	6	20

Two types of fractures were found have occurred in the present series 20% were comminuted and 80% were transverse fracture.

Fig-23: Graph showing type of fracture



Operation:

All cases were operated on our regular operation theatre days, at the earliest possible time. The patients were operated upon within an average period of 3 days after the injury.

Incision:

All the cases were operated upon by a vertical midline incision. The advantage of a vertical incision is that the patient can be mobilized early, the patients does not hesitate to do active flexion and there is less tension on the suture line during mobilization.

Immobilization:

None of the knee was immobilized at all and active flexion and quadriceps exercises encouraged from the beginning.

Follow Up:

Patients were followed up one month after discharge and then every 2 months. In this series the follow up period ranged from 2 months to 9 months. The mean time was 5 months. During each follow-up the patients were questioned about the following subjective complaints and examined for the followings deficiencies.

Table-5: Subjective Complaints following Modified Tension Band Wiring

Complaints	Number of Cases	Percentage
Pain	9	30
Mild Difficulty In Squatting	9	30
Difficulty In Climbing Stairs	-	-
Difficulty In Stepping Down Stairs	-	-
Sense Of Weakness Or Giving Way Of Knee	-	-

Pain:

All the cases had pain during the first 2 weeks. In the present study 21 cases gave excellent results were in they complained of no pain after 2 months. 7 cases considered to be good cases with mild pain at the end of 2nd month. 2 cases complained of persistence of pain even after the end of 2nd month is graded as poor.

Swelling:

During the first month swelling was present in all cases. At the end of 2nd month none of the cases had swelling.

Difficulty in Squatting:

In this series 9 of the patients had mild difficulty in squatting. But getting up from the squatting position was not difficult and one patient was unable to squat.

Table-6: Objective deficiency after modified tension band wiring

Deficiency	Number of cases	Percentage
Limitation of flexion	9	30
Quadriceps wasting of 1cm	9	30
Quadriceps power of grade-4	9	30
Extension lag	-	-

Movements:

In this series 8 cases had limitation of flexion of only terminal 20° of flexion and one case had only 40° of flexion and so 9 cases had limitation of knee flexion. All the other 21 cases had complete range of knee movement.

Wasting of Thigh:

In this series 9 cases had one centimeter wasting. Early and effective physiotherapy is essential in obtaining an excellent result.

Power of the Quadriceps:

Quadriceps strength was graded 0-5 from no muscle activity to full strength. It was assessed by comparing with the normal side. In this series only 9 cases had grade-4 strength. All the other cases had grade-5. Patient cooperation and physiotherapy are very important for the recovery of muscle power and function of knee joint.

Extension Lag:

None of the patients had extension lag.

Results:

In this 18 cases were male and 12 cases were female, 18 cases were having indirect injury and 12 were having direct injury. 21 cases graded as excellent, 7 cases graded as good and 2 cases as poor.

Criteria to grade the cases mentioned below:

1. Excellent:

This knee was functionally normal. The patient has no subjective complaints like pain, difficulty in squatting and climbing steps and objective deficiencies like quadriceps wasting and limitation of flexion and extension and normal quadriceps power.

2. Good:

There was occasional pain. Patient can squat and climb steps with some difficulty. Limitation of flexion less than 20°, quadriceps wasting less than 1 cm, and reduction of quadriceps power from grade-5 to grade-4.

3. Poor:

Cases which failed to attain the above standards.

Table-7: Results in this study

Results	Number of cases	Percentage
Excellent	21	70
Good	7	23.33
Poor	2	6.66

Fig-24: Graph showing results in this study

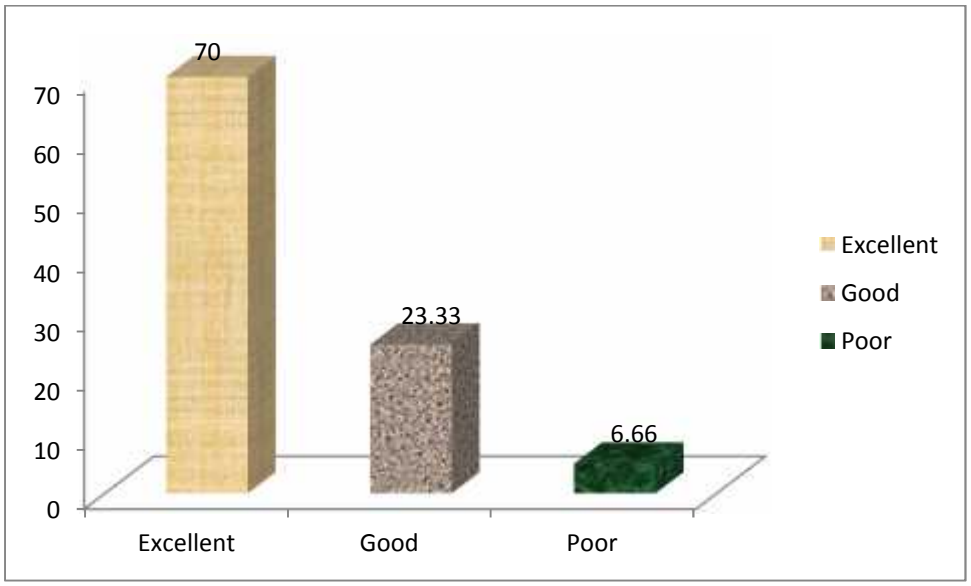


Fig 25 Case Illustrations

CASE I

PRE-OPERATIVE

INTRA OPERATIVE

IMMEDIATE POST-OPERATIVE

FINAL FOLLOW-UP

CASE II

PRE-OPERATIVE

INTRA OPERATIVE

IMMEDIATE POST-OPERATIVE

FINAL FOLLOW-UP

CASE III

PRE-OPERATIVE

INTRA OPERATIVE

IMMEDIATE POST-OPERATIVE

FINAL FOLLOW-UP

DISCUSSION

Since the advent of surgical treatment of the fractured patella, opinion has changed from one advocating removal of the patella to one preserving either part or preferably whole of the patella. If the fragments can be realigned and fixed in such a way that once it heals, it is in no way different from its pre-fractured status, it would be the ideal treatment. In this series 30 cases of fractured patella were treated by the modified tension band wiring technique. Special attention was given to mobilize the knee early as it helps to regain the quadriceps power. The findings, the end results and various other data will be analysed and compared in the following discussion.

Table-8: Age incidence

Age in years	Number of cases	Percentage
20-30	6	20
31-40	15	50
41-50	9	30

Fracture patella can occur at any age. But the frequency in children and adolescents under 20 years of age is low. In this series the range of age was taken between 20 to 50 years. The mean age was 45 years and maximum incidence was between 31 to 40 years. In Bostrom (1972) series, the mean age was 48 years ranging between 16 to 89 years.[28] S.K. Basu Ray and M.S. Ghosh in their series of 24 cases found the range of age between 18 years and 62 years In R.E. Peoples et al (1977) series, the average age was more than 20 years.[37]

Table-9: Sex incidence

Study	Male	Female
S.K.Basu Roy and M.S. Ghosh	71%	29%
Jonathan Wilkinson	68%	32%
Present study	60%	40%

In the present series 18 patients (60%) were males and 12 (40%) were females.

In the series of S.K. Basu Ray and M.S.Ghosh the incidence was 71% males and 29% females[36]. In Jonathan Wilkinson series, the incidence was 68% males and 32% females.[40] In general it can be said that the patella fracture commonly occur in males because of an active and vigorous life style. In present series also male sex predisposition was observed.

Nature of Trauma:

In this series 12 cases were due to direct injury and 18 cases due to indirect injury. Fall in the same plane was the most common 60%, assault with sticks directly over the patella 10% and road traffic accident 30%.

Type of Fracture:

Two types of fractures were found to have occurred in the present series 20% were comminuted and 80% were transverse fracture.

Subjective Complaints following Modified Tension Band Wiring:

In the present study subjective complaints like pain was observed in 9(30%) patients and difficulty in squatting was observed in 9(30%) patients.

Objective deficiency after Modified tension band wiring:

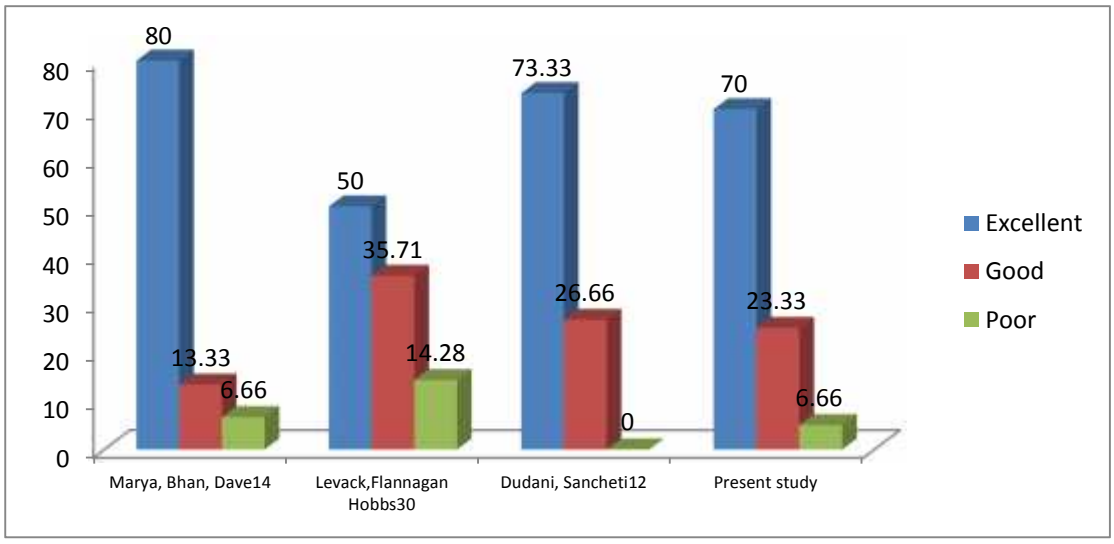
In the present study 9(30%) patients had flexion limitation, quadriceps wasting was observed in 9(30%) patients a quadriceps power of grade IV was observed in 9(30%) patients.

There was no extension lag in any of the cases.

Table-10: Results

Study	No of cases	Excellent	Percent	Good	Percent	Poor	Percent
Marya, Bhan, Dave[14]	30	24	80	4	13.33	2	6.66
Levack,Flannagan Hobbs[30]	14	7	50	5	35.71	2	14.28
Dudani, Sancheti[12]	15	11	73.33	4	26.66	0	0
Present study	30	21	70	7	23.33	2	6.66

Fig-26: Graph showing results comparison



In the present study 21 (70%) had excellent result, 7 (23.33%) had good results and 2(6.66%) had poor results.

Dudani, Sancheti[12] in their study also found similar results 11(73.33%) had excellent result and 4(26.66%) had good result.

Marya, Bhan, Dave[14] found 24(80%) had excellent result, 4(13.33%) had good result and 2(6.66%) had poor result.

But Levack, Flannagan, Hobbs[30] found 7(50%) had excellent result, 5(35.71%) had good result and 2(14.28%) had poor result.

SUMMARY

Thirty cases of fracture patella treated by modified tension band wiring technique at Shri B M Patil Medical College Hospital & Research Centre, Vijayapur have been studied.

- Maximum number of cases 15 (50%) were in the age group of 31-40.
- There was male sex predomination, 18(60%) were males and 12(40%) were females.
- 18(60%) cases are due to an indirect trauma to the knee joint, direct injury resulted fracture patella in 12 (40%) cases.
- 24(80%) cases are transverse fractures and 6 (20%) cases had comminuted fractures.
- A subjective complaint like pain was observed in 9(30%) patients and difficulty in squatting was observed in 9(30%) patients.
- 9(30%) patients had flexion limitation, quadriceps wasting was observed in 9(30%) patients a quadriceps power of grade-4 was observed in 9 (30%) patients.
- There was no extension lag in any of the cases.
- 21 (70%) cases had excellent result, 7 (23.33%) cases had good results and 2(6.66%) cases had poor results following modified tension band wiring procedure.

CONCLUSION

Fractures of the patella are common though rare below the age of 20 years. Fall in the same plane is the most common cause of fractures of the patella. Vertical incision is more helpful to mobilize the patient early. Early mobilization of the knee restores quadriceps power and range of knee motion within a short period. Excellent range of movement was achieved in 70% of cases.

Early and continuous physiotherapy following the modified tension band wiring technique is of paramount importance in determining the end results. Modified tension band wiring is therefore the choice of treatment for the fracture patella.

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ANNEXURES

B.L.D.E. UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103
INSTITUTIONAL ETHICAL COMMITTEE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 22-11-2014 *at* 3.30pm *to scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis has been accorded Ethical Clearance.*

Title "A Clinical Study of fractures of patella - treated with Modified tension band wiring"

— x — x — x —

Name of P.G. student Dr Ullas. T
Dept of Orthopaedics.

Name of Guide/Co-investigator Dr O. B. Pattanashetty
Prof & HOD. Dept of Orthopaedics.

for
DR.TEJASWINI. VALLABHA
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Following documents were placed before E.C. for Scrutinization
1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

INFORMED CONSENT FORM

BLDEU'S SHRI B. M. PATIL MEDICAL COLLEGE

HOSPITAL AND RESEARCH CENTRE,

BIJAPUR-586 103

TITLE OF RESEARCH	:	A CLINICAL STUDY OF FRACTURES OF PATELLA TREATED WITH MODIFIED TENSION BAND WIRING.
Principle Investigator	:	DR. ULLAS T
P.G. Guide Name	:	DR. O.B.PATTANASHETTY M.S ORTHOPAEDICS PROFESSOR AND HOD

All aspects of this consent form are explained to the patient in the language understood by him/her.

I, the undersigned,_____ , S/O D/O W/O _____, aged ____years, ordinarily resident of _____ do hereby state/declare that

Dr Ullas T of Shri. B. M. Patil Medical College Hospital and Research Centre has examined me thoroughly on _____ at _____ (place) and it has been explained to me in my own language that I am suffering from _____ disease (condition) and this disease/condition mimic following diseases. Further Dr Ullas T informed me that he/she is conducting dissertation/research titled "A Clinical Study Of Fractures Of Patella Treated With Modified Tension Band Wiring" under the guidance of Dr O. B. Pattanashetty requesting my participation in the study. Apart from routine treatment procedure, the pre-operative, operative, post-operative and follow-up observations will be utilized for the study as reference data.

Doctor has also informed me that during conduct of this procedure like adverse results may be encountered. Among the above complications most of them are treatable but are not anticipated hence there is chance of aggravation of my

condition and in rare circumstances it may prove fatal in spite of anticipated diagnosis and best treatment made available. Further Doctor has informed me that my participation in this study help in evaluation of the results of the study which is useful reference to treatment of other similar cases in near future, and also I may be benefited in getting relieved of suffering or cure of the disease I am suffering.

The Doctor has also informed me that information given by me, observations made/ photographs/ video graphs taken upon me by the investigator will be kept secret and not assessed by the person other than me or my legal hirer except for academic purposes.

The Doctor did inform me that though my participation is purely voluntary, based on information given by me, I can ask any clarification during the course of treatment / study related to diagnosis, procedure of treatment, result of treatment or prognosis. At the same time I have been informed that I can withdraw from my participation in this study at any time if I want or the investigator can terminate me from the study at any time from the study but not the procedure of treatment and follow-up unless I request to be discharged.

After understanding the nature of dissertation or research, diagnosis made, mode of treatment, I the undersigned Shri/Smt _____ under my full conscious state of mind agree to participate in the said research/dissertation.

Signature of patient:

Signature of doctor:

Witness: 1.
2.

Date:

Place

MANAGMENT :

INVESTIGATIONS:

- X-ray of knee joint Antero-posterior view and lateral view.
- Complete blood count.
- Bleeding time, Clotting time.
- Urine- Albumin, sugar and Microscopy.
- Random blood sugar, Blood urea and Serum creatinine.
- HIV , Hbs Ag and HCV.
- Blood grouping and Rh- typing.
- ECG.
- Chest X-ray- Postero-anterior view.
- Computed-tomography scan if necessory.
- MRI if necessory.
- Other specific investigations whichever needed.

Final Diagnosis:

TREATMENT:

- A proposed surgery with modified tension band wiring.

PROFORMA

Case No		Hospital:
Name		D.O.A :
Age	:	D.O.O.:
Sex	:	D.O.D.:
Address	:	IP No :
Occupation	:	
Complaints	:	

Pain

Swelling

Loss of function

Inability to bear weight:

History of Presenting Complaints

1. Duration of injury in hours
2. Pain in the knee joint
3. Swelling in the knee joint
4. Nature of the trauma Direct / Indirect due to
    a. Traffic accident
    b. Fall in the same plane
    c. Fall from a height
    d. Muscular violence
    e. Assault with stick
5. History of massage
6. Any associated injury

Past history :

Family history :

GENERAL PHYSICAL EXAMINATION

Pulse: BP:

Systemic Examination:

CNS:

CVS:

P/A:

RS:

LOCAL EXAMINATION OF THE KNEE JOINT

A. Inspection :

1. Attitude

2. Swelling

Size

Shape

Extent

Skin over the swelling

3. Presence of abrasion or laceration or contusion

4. Parapatellar pouches

5. Position of patellar fragments

6. Presence of sulcus

B. Palpation :

1. Local rise of temperature

2. Site of maximum tenderness

3. Palpable sulcus or defect

4. Palpable fragments

5. Position of fragments

6. Crepitus

7. Fluctuation

C. Measurements :

Circumference of thigh:

Affected side:

D. Movement :

Flexion	Active	Degree	Painful / Painless
	Passive	Degree	Painful / Painless
Extension	Active	Degree	Painful / Painless
	Passive	Degree	Painful / Painless

Normal side :

E. Examination of the other knee joint:

INVESTIGATION

1. Blood:

Hb%: TC: DC: ESR: CT :

BT: HbsAg: HIV: HCV :

2. Urine: Alb Sugar Micro

3. X-ray Examination Film No. Date

Type of fracture :

TREATMENT

■ Preoperative

■ Operation

- Date

- Anaesthesia : Procedure

• Findings

FOLLOW UP

■ Date

SIGNS AND SYMPTOMS

1. Pain
2. Swelling
3. Difficulty in squatting
4. Difficulty in climbing
5. Sense of weakness/ give away
6. Movements:

Flexion	Active	Degree	Painful / Painless
	Passive	Degree	Painful / Painless
Extension	Active	Degree	Painful / Painless
	Passive	Degree	Painful / Painless

7. Extension lag

8. Efficiency/power of quadriceps grade:

9. Circumference of thigh operated side:

10. Circumference of thigh normal side:

11. Advice:

No. :

Date:

MASTER CHART

Sl No	Name	IP No	Age/Sex	Nature of Trauma	Fracture Side	Type of Fracture	Fracture Surgery Interval	Tear in retinacular Fibres	Hospital stay days	Follow up month	Subjective symptoms	Objective symptoms	Results
1	Akram Pasha	1152	35y/M	Indirect	L	T	3	YES	15	8	-	-	Excellent
2	HemavathiNaik	1423	46y/F	Indirect	R	C	2	YES	14	9	-	-	Excellent
3	UmeshDayanand	1539	40y/M	Indirect	R	T	3	YES	15	4	1,2	4,5,6	Good
4	BharathiBhajantri	2327	37y/F	Indirect	L	T	2	YES	14	7	-	-	Excellent
5	VeereshHanamanth	4057	40y/M	Indirect	R	T	3	YES	15	6	-	-	Excellent
6	UmadeviNagani	5479	36y/F	Direct	R	C	2	YES	14	7	-	-	Excellent
7	BhavaniRathod	7179	42y/F	Indirect	R	T	3	YES	15	2	1,2	4,5	Good
8	Sangamesh Math	9271	41y/M	Indirect	L	T	2	YES	14	6	-	-	Excellent
9	RakeshPawar	11802	30y/M	Indirect	R	T	3	YES	15	7	-	-	Excellent
10	KamalawwaPujari	17156	35y/F	Indirect	R	T	2	YES	14	6	2,3	4,5,6	Good
11	SharanappaHiremath	17429	45y/M	Indirect	R	C	3	YES	15	6	-	-	Excellent
12	Deepak Chavan	17874	36y/M	Indirect	R	C	2	YES	14	5	-	-	Excellent
13	AmbubaiRathod	18294	35y/F	Indirect	L	T	3	YES	15	6	-	-	Excellent
14	KashinathBabu	20327	30y/M	Indirect	R	T	3	YES	15	7	2,3	4,5,6	Poor
15	MeenaxiBiradar	20758	38y/F	Indirect	R	T	3	YES	15	5	-	-	Excellent
16	GangadharNagthan	21002	48y/M	Direct	R	T	2	YES	14	6	-	-	Excellent
17	SangeethaPatil	22493	38y/F	Indirect	R	T	3	YES	15	5	1,2	4,5,6	Good
18	Haji Mastan	22676	45y/M	Indirect	L	T	2	YES	14	6	-	-	Excellent
19	JyothiBadiger	23404	32y/F	Direct	L	T	3	YES	15	5	-	-	Excellent
20	Bhagirathi Sindagi	23712	45y/F	Direct	L	C	3	YES	15	6	-	-	Excellent
21	MallappaPujari	24977	50y/M	Indirect	R	T	3	YES	15	6	-	-	Excellent
22	IrappaKattimani	25218	26y/M	Indirect	R	T	2	YES	14	5	-	-	Excellent
23	IshwarBiradar	25261	23y/M	Direct	L	T	3	YES	15	6	1,2	4,5,6	Good
24	SavitaMulimani	34952	25y/F	Direct	R	T	2	YES	14	6	-	-	Excellent
25	UdaykumarKembhavi	36887	34y/M	Direct	L	T	3	YES	15	6	1,2	4,5,6	Good
26	ShantabaiChalawadi	37552	35y/F	Direct	L	C	2	YES	14	4	2,3	4,5,6	Poor
27	DareppaDashwant	38236	33y/M	Indirect	R	T	2	YES	14	5	-	-	Excellent
28	BasayyaMathapathi	39987	50y/M	Direct	R	T	2	YES	14	6	-	-	Excellent
29	Kumar Patil	41380	29y/M	Direct	L	T	3	YES	15	5	1,2	4,5,6	Good
30	Ramappa Joshi	41845	45y/M	Direct	L	T	2	YES	14	6	-	-	Excellent

KEY TO MASTER CHART

1	OCCASIONAL PAIN
2	DIFFICULTY IN SQUATTING
3	PERSISTANCE OF PAIN
4	LIMITATION OF FLEXION
5	QUADRICEPS WASTING
6	MUSCLE POWER GRADING-4
L	LEFT
R.....	RIGHT
T	TRANSVERSE FRACTURE
C……	COMMINUTED FRACTURE