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A comparative study of modified tension brand wiring and cerclage wiring in management of transverse fractures of patella

Anand. B. Jabshetty

Department of Orthopedics, BRIMS Medical College, Bidar, Karnataka-585401, *India*
docanand.joc@gmail.com

Abstract

Management of patellar fractures is controversial. This study compares the results of two commonly used methods of internal fixation for transverse fractures of patella namely cerclage wiring and modified tension band wiring. Outcome of treatment of twenty (20) cases of transverse fractures of patella from the 2 hospitals attached to the MRMC Medical college, Gulbarga, India were studied between March 2003 to February 2005. Group -A consist of 10 cases which were treated with modified tension band wiring and group-B consist of 10 cases treated with cerclage wiring. Union was achieved in all 20 cases results were compared by using modified Bostman scale. Nine out of 10 patients treated with modified tension band (Group-A) has excellent to good results, 7 patients had knee flexion more than 120°, 8 patients had near normal quadriceps power and 1 patient had extensor lag. In group-B which were treated with cerclage 8 out of 10 patients had excellent to good results, 6 of them had knee flexion of more than 120°, 7 of them had near normal quadriceps power and 2 of them developed extensor lag. Out of 20 cases, 3 cases were compound Grade-I. All 3 cases healed satisfactory, one developed infection leading to stiffness. The results were comparable to closed group. Quadriceps wasting were seen in all 20 cases but it was minimal in group-A treated with modified tension band wiring may because of shorter period of immobilization. It was found that the results of all the cases were comparable but cases treated with modified tension band wiring showed better results as compared to cerclage wiring as the stability of implant is better and post operative rehabilitation is faster. Compound grade-I fractures of patella shows good results when treated by internal fixation.

Keywords: Fractures, Patella, Injuries, Cerclage, Quadriceps, Health care

Introduction

Patella is the largest sesamoid bone situated in front of knee joint in the tendon of quadriceps femoris. Patellar fractures constitute about 1% of all skeletal injuries (Campbell's Operative Orthopedics, 9th Edition; 1998; Vol. 3: 2111-2114.). The subcutaneous location of patella on the anterior aspect of knee makes it vulnerable to direct trauma. Fractures caused by indirect mechanism results from violent contraction of the quadriceps when knee is flexed. The patella, as it is the principal site of insertion of the quadriceps muscle, transmits the tensile forces generated by the quadriceps muscle, to the patellar ligament. The patella effectively increases the lever arm of the knee extension mechanism from the axis of knee flexion - extension. Also, the presence of the patella increases the radius from the center of the knee, thereby increasing the mechanical advantage of patella-quadriceps mechanism and making knee extension more efficient. There is no universally accepted treatment for patellar fractures. The patellar fractures were initially treated conservatively. For many years, patellectomy was the treatment of choice for patellar fractures, as many authors believed that the patella inhibited the action of the quadriceps tendon and that patellectomy gave excellent results with only minimal loss of function. When patella is absent, the effective radius of the patella-quadriceps pull from the center of rotation of the knee is shortened, thereby requiring more quadriceps force to accomplish the same degree of powerful knee extension. When patella is excised, extension is transmitted to the tibia through lateral expansion and greater the mid-guided effort to shorten the central tendon, the greater the over-lengthening of the expansion and the greater the loss of power. Various internal fixation techniques have been described like, circumferential wiring, tension band wiring, modified tension band wiring in combination with Kirschner wire or lag screw fixation, etc. However controversy still exists over which is the best method of surgical treatment. The goal of the treatment is to re-establish the continuity of the extensor mechanism and to restore the normal function of the knee. In this present study an effort is made to compare the two most commonly used operative treatments for the commonest transverse fracture of the patella. To study fractures of patella and analyze the results of modified tension band wire and cerclage wire in the treatment of transverse fracture patella. To prevent complications associated with conservative treatment like loss of extensor mechanism and incongruity of patello-femoral articulation, postoperative rehabilitation after fixation of patellar fractures. This study was conducted to compare and analyze the results between modified tension band wiring and cerclage wiring in Transverse fractures of Patella.

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Biomechanics of patella-femoral joint

The patella is one link in the mechanism comprising the quadriceps muscle, the quadriceps tendon, the patella, and the patellar ligament. The mechanism serves two important biomechanical functions. Firstly, as it is the principal site of insertion of the quadriceps muscle, it transmits the tensile forces generated by the quadriceps to the patellar ligament. Secondly, the patella effectively increases the lever arm of the knee extension mechanism from the axis of knee flexion - extension. This increases the knee extensor moment generated by contraction of the quadriceps. The patella serves as pulley and increases the leverage of the quadriceps muscle allowing it to act over greater angle. Park *et al.,* (2010) were of the opinion that the patella keeps the extensor tendon away from the functional axis of the joint in all positions and thus it increases the efficiency of the quadriceps action.

Park *et al.* (2010) observed that the total tension generated by a muscle decreases as the muscle was short ended. They opined that after patellectomy, the length of quadriceps muscle decreased. They found that the patella serves to increase the magnitude of the quadriceps moment arm and that the contribution made by the patella increases with progressive extension of the knee, being almost 30% at full extension. It is an observed fact that the patella normally keeps the quadriceps tendon above the level of tibial plateau even in full extension of the knee. Either in vertical or improper transverse repairs of the quadriceps mechanism following total excision of the patella, the repaired part of the tendon falls into the intercondylar fossa instead of standing over the upper levels of femoral condylar surfaces. In such a case the quadriceps tendon is always at a lower level than tibial plateau in full extension of the knee. The quadriceps tendon corresponds to the level of tibial tubercle only when the knee is short of 5 to 10 degrees of full extension. Thus, improper quadriceps repair is responsible for the extension lag of the knee. If the quadriceps tendon and patellar tendon are snuggly approximated and sutured, the resultant repaired tendon is always situated above the level of tibial plateau even in full extension of the knee. Thus, the extensor lag of the knee is avoided, the efficiency of the quadriceps muscle and good contour of the knee are maintained. The patella is subjected to complex loading. With knee extension, it transmits almost all of the force of the quadriceps contraction and thus is loaded primarily in tension. However, with knee flexion, its posterior surface contacts the distal aspect of the femur and is subjected to a compressive force, generally called the patellofemoral joint reactive force. Loading on this surface creates a three - point - bending configuration in the patella (James H. Beaty, 2009). This bending load results in tension at the anterior surface of the patella. As the knee moves into greater flexion, the bending forces become increasingly important. The magnitude of tensile forces in the anterior surface of the patella reaches a maximum, near 45 degrees of knee flexion.

Considering the magnitude of tension, three point bending stress, and compressive forces that occurs on the posterior surface of the patella in a loaded, flexed knee, the prevalence of patella fracture is not surprising. The force with which the patella contacts the articular surface of the distal aspect of the femur can be estimated analytically with the use of the primary quadriceps force data reported for a variety of activities and knee flexion angles.

Biomechanics of the extensor apparatus

The principal function of the extensor mechanism of the knee in humans is to maintain erect posture. Activities such as ambulation, rising from chair and descending or ascending stairs are typical examples. The force necessary for knee extension is directly dependent on the distance between the patellar tendon and the knee flexion axis. Twice the force is needed to extend the knee in the last 15^0 than to extend from fully flexed position to 15^0 short of full extension. To do this the knee requires a moment arm that increases during extension so that it can maintain a constant level of torque. Patella provides this mechanical advantage by two separate mechanisms, linking and displacement. The area of contact of articular cartilage between the patella and distal femur varies according to the position of the knee.

Linking function occurs in the more flexed position. At 135^0 of flexion the patella slips into the intercondylar notch. The patellar facet of the femur exhibits an extensive contact area with both the patella and broad posterior surface of the quadriceps tendon. From 135^0 flexion to 45^0 the odd facets engages the femur. From 45^0 of flexion to full extension the upper and middle portion of patella is the only component of extensor mechanism in contact with the femur with knee in full extension, the lower portion of patella is in contact with femur. It acts to displace the quadriceps tendon - patellar tendon linkage away from the axis of knee rotation. This increases the effective moment arm of the quadriceps mechanism and contributes to additional 60% torque that is needed to gain last 15^0 of knee extension (Shrinivas *et al.,* 2004). By displacing the tendon away from the axis of rotation, a greater excursion of the quadriceps is required for a given range of motion. In patients with patellectomy the increase in the moment arm in the last 15^0 of extension is lost and hence the additional torque required for last 15^0 of extension is lost. Hence the extensor mechanism is at a disadvantage and becomes weak.

Radiographic evaluation

It includes standard views like antero-posterior and lateral, specialized views like axial or skyline, CT

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scan, bone scintigraphy, Magnetic Resonance Imaging.

Standard views

*Antero-posterior view***:** In patellar fractures, AP view is taken with patient supine and X-ray plate underneath knee. X-ray should include lower half of the thigh and upper half of the tibia. Evaluation of the AP view should be carefully done. A bipartite patella may be confused for a marginal fracture of the patella. The X-ray of the opposite knee may be taken to rule out a bipartite patella, as it is usually bilateral.

Lateral view: A transverse fracture is well seen in a lateral view. The articular congruity can be assessed in a well-positioned lateral view. With the knee flexed to 90^0 the proximal patellar pole normally lies posterior to the anterior surface of the femur. With a ruptured patellar tendon, the proximal patellar pole rests anterior to the anterior surface of femoral shaft. The most reliable method of assessment of the patellar height is Insall's index (Park *et al.,* 2010). This technique employs the ratio of the greatest diagonal patellar length and the patellar tendon length. In normal individuals the ratio is 1. A ratio less than 1 suggests a high riding patella (Patella Alta). Up to 20% variance is acceptable. In Blumensatt's line, knee is flexed to 30º, the line passing through the intercondylar notch should just touch the lower pole of patella.

Skyline view or Axial view or Merchant's view

In vertical fractures, marginal fractures and osteochondral fractures, this view is very much helpful. Merchant *et al*. (1974) described a method of obtaining axial view of the patella. Patient is placed supine with the knee flexed to 45^0 on the end of the table; the knee is elevated slightly to keep the femur horizontal and parallel with the table surface. An X-ray beam is angled 30^0 from the horizontal. The cassette is then placed about 1 foot below the knee and perpendicular to the X-ray beam.

Bone Scan or CT

The main indication for CT and bone scan is the detection of occult fractures. Some authors recommend tomography over bone scan in these cases especially for stress fractures in the elderly with osteopenia and haemarthrosis.

Magnetic Resonance Imaging

MRI is mainly used for extensor mechanism injuries, ligament injuries and meniscal injuries. It is rarely indicated in patellar fractures.

After patellectomy careful reconstruction of extensor mechanism should be performed. For open reduction and internal fixation, many methods can be used, but the commonly used methods are Modified tension band wiring, Cerclage wire, Combination of tension band wire and cerclage wire and Cancellous screw fixation.

Conservative or non-operative treatment

Conservative treatment is indicated in undisplaced or minimally displaced transverse or stellate fractures when extensor apparatus is intact and patient is able to do active extension.

Bostrom (1972) accepted 3-4mm fragment displacement and 2-3mm articular incongruity for non-operative treatment. Heamarthrosis if present should be aspirated before application of cast. A cylinder cast in extension is required for 4-6 weeks. Early weight bearing is encouraged by Smillie (1970) and slowly advanced to full weight bearing with crutches as tolerated by patients. The cylinder cast should be from high groin to just above the malleoli. After removal of the cast progressive range of movement exercises and quadriceps strengthening exercises are advised.

Operative treatment

The indications of operative treatment are: pen fractures, fractures with extensor apparatus discontinuity, if fragments are displaced more than 3-4mm, if articular incongruity more than 2-3 mm present and osteochondral fracture with displacement of fragment in the joint.

Surgical optional availability

It includes: open reduction and internal fixation using a metal implant. Repair of quadriceps with retention of one major fragment - partial patellectomy, Total patellectomy with repair of quadriceps mechanism.

*Open reduction and internal fixation***:** The common approach and techniques for patellar fractures includes the transverse curved incision approximately 12.5 cm long, anterior midline vertical, parapatellar-lateral or medial. When the skin is normal, procedure should be performed as early as possible.

Materials and methods

Twenty adults with age group of 20 and above with transverse fractures of patella treated in two hospitals attached to MRMC Medical College, Gulbarga, Karnataka, India between March 2003 to February 2005 were chosen by randomized sampling method. The study includes prospective cases of Closed displaced transverse fractures of patella and Compound grade-I transverse fractures of patella only. The Communited or stellate fractures of patella, Undisplaced fractures of patella, Fractures of patella in children, Fractures of patella associated with ipsilateral limb injuries in whom Postoperative rehabilitation not possible, Grade-II or III compound fractures of patella were excluded from the study. Out of 20 cases, A group of 10 cases experienced Cerclage wiring and another group of 10 cases underwent the Modified tension band wiring method of treatment. The follow-up period was minimum of 6 months. The criteria for comparison between the 2 groups of treatments were: duration of healing, range of movement of knee joint, quadriceps atrophy and power, ability to walk without aid, ability to squat and staircase climbing, extensor lag and complications. All selected cases were healthy and with active life. The mode of trauma was either RTA or fall on the knee. All the patients were admitted to the hospital, examined clinically,

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radiologically and routine blood investigations were done. The patients were taken for surgery as early as possible. Patients who had associated fracture of the same extremity as fracture shaft femur or tibia were excluded from the study because post-operative rehabilitation was difficult to compare.

Procedure

All the patients were assessed carefully clinically for any associated injuries and general condition. All the patients coming under exclusion criteria were excluded from the study. The patients usually presented with painful swelling of the knee joint and difficulty to bear weight on that limb. As patella is a subcutaneous bone gap at fracture site may be palpable. The patients' ability to extend the knee actively is documented as it gives the clear idea about the continuity of the extensor mechanism. In most of the transverse displaced fractures, the ability to extend the knee is lost because of tear of extensor mechanism. Then the patient is shifted to radiology department for X-rays. Anteroposterior and lateral views of knee are taken including lower 3rd of thigh and upper third of leg. Lateral view is more important as it gives idea about the communition, displacement and articular congruity. As few of the patellar fractures lead to huge heamarthosis of knee joint, patients presented with tense swelling of the knee joint. These patients were aspirated immediately to relieve pain. Compression bandage was given after the aspiration and patient was put on a above knee pop slab in extension. Some of the cases presented with heamarthosis not much on first day and developed on next day. These were aspirated after 48 hours or during operation. After this patient is shifted to ward with above knee pop slab and investigated for: CBC - HB, TC, DC, ESR, Urine routine, Blood grouping and Rh-typing, Random blood sugar, HIV, HbsAg. X-Ray - Chest PA view and ECG, if patient is above 35 years of age.

The radiographs were assessed for the fracture configuration and degree of communition and articular incongruity. Depending on the x-ray, patient's general condition, age of patient and bone quality, the treatment was decided. Patient was then planned for operation as soon as possible. On the previous day of operation, the part (knee) was prepared with savlon, betadine and then with spirit and draped with sterile bandage. Intraoperative antibiotic was given during the procedure. 1 gm of cefotaxime sodium or ceftriaxone and it was continued for next 3 days and then shifted to oral antibiotic if wound is clean on first dressing.

The results were graded as excellent, good and poor depending upon above scale. Attention is given to quadriceps atrophy, power, and range of motions of knee, extensor lag, squatting and ability of staircase climbing.

Results

Twenty cases of fracture patella were included in this study. Out of these 10 were treated with modified tension band wire and 10 with encerclage wiring. Age distribution of the cases Thirty five percent of cases were between 20-30 age group, 20 % of them were between 30-40 age group, 25 % were between 40-50 age group, 15 % of them were 50-60 age group and 5 % of the cases were above 60 age group. The youngest patient was of 21 years age and oldest was 62 years of age. Maximum numbers of cases were in the age group of 21-30 i.e., 7 (35%). Out of 20 cases, 15 were male and 5 were female. There was a male preponderance with a male-female ratio of 3:1. Right patella was involved in 65% cases, which is commonest side. Left side was involved in 35% of cases. Sixty percent of the cases consisted of fall injuries and rest were of RTA. Interval between Trauma and Surgery was 0-10 days. Sixty five percent of surgeries were done with transverse incision, 20 % of surgeries were done with Midline longitudinal incision and rest were done with Parapatellar incision.

Out of 20 cases, there were 15 males (75%) and 5 were females (25%). It might be because males are more active in India, the fracture is more common in them. Right side was involved in 13 cases i.e., 65% of cases. Interval between trauma and surgery was less than 5 days in 8 cases and 5-10 days in 7 cases and more than 10 days in 5 cases. The commonest mode of injury was fall on knee, which was seen in 12 cases i.e., 60% of cases and the rest 40% had road traffic accident. During operation in 2 cases, which was showing transverse fracture on radiograph found to have communition and these cases were excluded from the study. Injury to surrounding structure was not seen. The quadriceps apparatus tear was seen in all cases but complete tear was seen in 12 cases. Rest 8 cases had partial tear. Breakage of stainless steel wire was seen in 3 cases of encerclage wiring. It was during twisting of wires. In 2 cases, the patella was so osteoporotic that crushing was evident on twisting. Post-operatively 2 patients showed superficial infection out of 2 one was compound grade-I fracture. In one case, superficial infection healed satisfactorily after continuation of IV antibiotics for 7 days. In other case it took almost a month for wound healing. IV antibiotics were used for 2 weeks and dressing done regularly till then. This patient developed postoperative stiffness. Two cases developed stiffness of knee on follow-up, one responded to manipulation under general anesthesia, which was done after 4 months but the other, did not responded. One patient had hardware problem. The K-wires were too long and started irritating the skin below patella. Patient was taken to OT again to cut the lower end of wires. After this the fracture healed satisfactorily. Out of 20 cases, 4 were having pre-existing osteoarthritis of knee joint on X-ray but only one was symptomatic. On follow-up, one patient showed to have breakage of stainless steel wire after 14 months in case of cerclage wire, which was removed after breakage. Range of movements of knee

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was seen full in 7 cases and more than 120º in 7 cases and less than 120º in 6 cases i.e., 70% shown to have good range of movements of more than 120º flexion (Table 1). Quadriceps power was near normal in 15 cases ie., 75% but 5 cases had quadriceps power of grade-IV. Extensor lag was seen in 3 cases (Table 2). One case was treated with modified tension band wire and 2 cases of cerclage wire. No case was shown instability but 3 cases had the giving way sensation on walking.

Table1. Range of knee movements

Range of movement (Degree)	Modified tension band wiring		Cerclage wiring	
	No. of cases	%	No. of cases	%
Full	4	40	3	30
More than 120	3	30	3	30
Less than 120	3	30	4	40

Table 2. Quadriceps power

Quadriceps power	Modified tension band wiring		Cerclage wiring	
	No. of cases	%	No. of cases	%
Grade-V	8	80	7	70
Grade-IV	2	20	3	30

Out of 20 cases, 6 had grade-IV quadriceps power and the rest 14 had grade-V power.

Extensor lag

Extensor lag was seen in 3 cases, 2 treated with cerclage wire and 1 treated with modified tension band wire. Range of movements of knee were fast to regain in cases of modified tension band wiring as the movements were started early in postoperative period as compared in cases of cerclage wiring. But at the final follow-up of 6 months or 1 year, the difference was not much. The gain of quadriceps power was also quicker in cases treated with modified tension band wiring but at final follow-up, the difference was insignificant. The wasting of quadriceps was more in cases of cerclage wire (Table 3).

Table 3. Quadriceps wasting was seen in all cases

Quadriceps wasting (mm)	Modified tension band wiring		Cerclage wiring	
	No. of cases	%	No. of cases	%
0 - 10	5	50	2	20
11 - 20	4	40	8	80
21 - 30	1	10	--	--

Associated fractures

Out of 20 cases, 4 cases had associated injuries. Among these 4 cases, 2 had colles fracture, one had fracture of 6th rib and one had 3rd and 4th metacarpel fracture. Patients with fractures of ipsilateral limb were excluded from the study.

Discussion

In this present study, 20 cases of transverse fractures of patella has been studied. Out of this 10 were treated by modified tension band wiring using 2 parallel K-wires and anterior figure of 8 stainless steel wire and the other 10 cases treated with cerclage wire. Initially before the start of 19th century patella was thought to be unnecessary bone and all fractures were treated by patellectomy but the view started changing slowly. As early as in 1909, Heineck concluded that even though patella is not necessary for locomotion, total patellectomy for simple fractures is to be condemned. He recommended that patellectomy should be done only in severely communited fractured. He also stated that patellectomy leads to impairment of power and some functional loss.

According to Kaufer (1971), 30% increase in the pull of quadriceps is necessary to compensate for the loss of patella. Haxton in 1945 also stated that patellar presence improves the efficiency of quadriceps. Smillie (1970) stated that, patellectomy leads to loss of 5-15º of final extension. Campbell[1] observed that total patellectomy leads to decrease in extensor strength and development of extensor lag and it has a role only in severely communited and grade-III compound fractures. Twice the force is required to extend the last 15º of extension of the knee than to extend from fully flexed position to 15º short of full extension. For this, the knee requires something that increases the moment arm during extension so that it can maintain a constant level of torque. Patella provides this mechanical advantage patella acts to displace the quadriceps tendon away from the axis of rotation of the knee. During the last 15º of knee extension, the effective moment of arm contributes to the additional 60% of the torque needed to gain last 15º of extension. In patients with patellectomy this is lost, hence additional torque is lost. Hence the extensor mechanism is weak.

In our present study 10 cases were treated with modified tension band wiring of Pauwel. This is recommended treatment by AO/ASIF group. This is the most widely accepted treatment worldwide. Studies have shown high percentage of results in cases treated with modified tension band wiring (Levack *et al*. (1985). We have 4 cases with excellent results i.e., 40%. 5 cases shown good results i.e., 50% and only 1 case had poor results i.e., 10%. The overall results of 20 cases were comparable to most of the series. In our study group, 6 cases has excellent results i.e., 30% and 55% (11 cases) has good results and only 15% (3 cases) had poor results. Early mobilization of joint after surgery appears to have greatly helped to gain good range of motions, which is prime requisite for squatting.

Majority of our patients were satisfied with range of motion gained particularly necessary for the oriental habits of squatting and sitting cross-legged. Our results are comparable to Dudani and Sancheti (1981), where 15 cases were treated with modified tension band wiring and also comparable with that of Srinivaslu *et al*. (1984) which consists of 55 patients, among them 15 were treated with internal fixation.

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Our youngest patient was of 21 years age and eldest was of 62 years. Majority of the patients i.e., 80% (16 cases) were in the age group of 21-50 years. Srinivaslu *et al.* (1986) also reported that majority of patients were in the age group of 21-50 years; youngest being 19 years of age and eldest was 70 years of age. In another study by Dudani and Sancheti (1981) 80% of cases were in the age group of 21-50 years. In the study of Ozdemir & Ozenci (2001), the youngest patient was 18 years and eldest was 68 years. The results of 20 cases were graded as good and moderate in 90% cases and poor in 10% of cases. In our series, excellent and good results were in 85% and 15% were poor results. In the series of Berg (1997), 70% of the patients showed excellent to good results compared to 85% in the present study. In our study, male predominance was noted. Out of 20 cases, 15 (75%) cases were male and 25% were female with a ratio of 3:1. In Dudani and Sancheti series the ratio is 2:1 and in the series of Srinivaslu *et al*, (1986) it was 4.5:1 (M: F). Shabat *et al.* (2003) reported the ratio of female-male as 2:1, whereas Ozdemir reported the male-female ratio 2:1.

In the present study, right side was more common i.e., 13 cases (65%) and 35% were left sided. In Dudani and Sancheti series, right side was affected in 60% and left in 40% of cases. In our study, postoperative suction drainage was used in all the cases, but it was not reported in other series. In the present study, in patients treated with modified tension band were immobilized for two weeks and knee mobilization exercises were started after that and in patients treated with cerclage wire, the mobilization exercises were started after 4 weeks. In the series of Srinivaslu *et al*, (1986), the mobilization exercises were stated as soon as patient could tolerate it. In the series of Dudani and Sancheti (1981) the mobilization exercises were started on 11^{th} and 14^{th} day. In our series, in cases treated with modified tension band wiring, the movements of knee were started after two weeks compared to 4 weeks in cases of cerclage wire so the gain of movements of knee were faster in cases of modified tension band wiring. By the end of 6 weeks, 7 (70%) cases had flexion of greater than 90º.

In the present series, 13 patients i.e., 65% have gained knee movements of more than 120º. In Dudani and Sancheti (1981), 73% of cases had more than 120º of flexion: whereas in Srinivas *et al* (1984), series, all (100%) cases had full range of movements. In the present study, 3 patients (15%) had extensor lag, whereas there was no case of extensor lag in both the series compared. In our present study, 80% of patients had normal quadriceps power and 20% had grade-IV power of quadriceps in cases treated with modified TBW. Whereas, in cases treated cerclage wire 70% had normal power. In Srinivas *et al* (1984), series, normal power was in 93% of patients. In the study of Jakobsen *et al*. (1985) and Edwards *et al*. (1989) reduction in quadriceps strength was seen in 33% and 44% cases respectively. In our study, 2 (10%) cases developed superficial infection which healed satisfactorily after IV antibiotics and 2 cases developed stiffness of knee, out of which one responded to manipulation under general anesthesia. One patient developed hardware problem of protruding K-wires in a group of modified tension band wiring. In the series of Dudani and Sancheti (1981) following complications were noted: Bursa formation over K-wires, Proxymal migration of K-wires in one case, Distal migration in one case, Calcification in ligamentum patellae in one case. In series of Berg (1997) infection was seen in 20% cases. Gosal HS reported infection in 8% of cases. Union was seen in one case at 10-14 weeks in modified tension band wiring and 14-18 weeks in cerclage wire group compared to 12-16 weeks of Srinivaslu *et al* (1986), series. In the series of Rudolph and Rosenberg (1954), 84% of cases showed excellent to good results and remaining showed poor results. Study conducted by Nerliker, 90% of cases showed excellent to good results and 10% cases showed poor results. 75% of our cases had normal to near normal quadriceps power and rest had grade-IV power. Out of 20 cases, 2 had symptoms of giving way or instability. These symptoms were also considered in Bostman *et al.* (1981) scale (Table 4). Radiologically the fractured surface showed good alignment in all cases except 3 cases, which showed a step in lateral view but this did not affect the functional results.

In 60% of our cases, the mechanism of injury was fall on the knee and in other 40% cases it was RTA. In the study of Shobat and Mann (2003), fall accounted for 82% of cases.

In our series, 3 cases were compound fracture i.e., 15% of cases, but compound fractures are very rare in the other series. We did not came across the complications of avascular necrosis of patella in our series. Depalma (1954) considered it to be a rare complication. Avascular necrosis affect the proxymal fragment more than distal fragment. Wide separation of the fragments for a significant time makes patella prone for the above complications. Out of this 162 were transverse fractures and 41 of these showed partial necrosis of patella. Einola *et al*. (1976) did a long-term follow-up after patellectomy for fracture with special reference to functional disability. They had 22% good and 66% fair results. In their series weakness was seen in quadriceps muscles. A decrease in extension power was noted in patellectomized knee was 55% of the normal knee. Descending stairs was impaired in 79% of the patients. By studying all the above series, it is evident that quadriceps weakness is very common after patellectomy considering the overall discussion, we feel that patella should be preserved in as many cases as possible. We have also compared our study with closed fractures of patella done by Srinivas *et al*. (2004)

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Table 4. Modified scale of Bostman et al. (1981)

		Points
A	Range of motion 1.Full extension ROM> 120 2.full extension ROM 90 to 120 3.Loss of free extension Rom<90	 6 4 0
B	Pain 1.None or minimal 2.Moderate on extension 3.During daily activities	 6 3 0
C	Work 1.Original work 2.Different job after surgery 3.Cannot work	 4 2 0
D	Atrophy of quadriceps- 10cms above upper border of patella 1.Less than 12mm 2.12mm-25mm 3.More than 25mm	 4 2 0
E	Walking aid 1.None 2.Part time 3.Full time	 4 2 0
F	Effusion 1.None 2.Reported to be present 3.Present	 2 1 0
G	Giving way 1.None 2.Sometimes 3.All the time	 2 1 0
H	Stair case climbing 1.Normal 2.Difficult 3.Disabling	 2 1 0
I	Squatting 1.Comfortable 2.Difficult 3.Not able to squat	 2 1 0
	Results Excellent---29 to 32 points Good--23 to 28 points Poor--below 23 points	

conducted at Nizam's Institute of Medical Sciences, Hyderabad. They studied 32 cases of fracture patella. Out of which 10 were treated by modified tension band wiring, 12 with partial patellectomy and 10 with complete patellectomy. The youngest patient in their study was 12 years and the eldest 65 years while in our study the youngest was 21 years and eldest 62 years. The male to female ratio was 9:1 as compared to 3:1 in our study. Range of movement of more than 110º was seen in 90% of cases in their study compared to 80% of our study. Quadriceps wasting was evident in almost all cases in the present study. It was 0-10 mm in 50% of cases and more than 10mm in 50% of cases of modified tension band wiring and their study, it was not seen in 60% of cases, less than 15 mm in 20% of cases and more than 15 mm in 20% of cases. Quadriceps power loss was seen in 20% of cases in the present study and in the study of Srinivas *et al*. (2004) it was more than 25% loss in 20% of cases. Extensor lag was seen in only 1 case (10%) in our study treated by modified tension band wiring whereas it was seen in 20% of cases in the study by Srinivas *et al*. (2004). The overall results of our study were excellent to good in 85% of cases. In cases treated with modified tension band wire, excellent to good results were seen in 90% of cases. According to Srinivas *et al*. (2004), 80% of cases treated with modified tension band wiring shown to have excellent to good results and 20% shown poor results. The complications seen in our study was 10% had superficial infection, but in the study of Srinivas *et al*. (2004), no infection was noted. 2 cases, out of ten treated with modified tension band wire had the problem of irritation from implant, which was seen in only 1 case in our study. One case of deep vein thrombosis was seen by Srinivas *et al*. (2004), which was not noted in any of our cases.

Comparison between modified tension band wiring and cerclage wire

In our present study, an effort is made to compare the results of cerclage wiring and modified tension band wiring in the cases of transverse fractures of patella. Our study group consists of 20 cases, 10 cases each from both groups. Union was seen in all the 20 cases, but the union was faster in cases of TBW. The average period of union was 10-12 weeks in cases treated with modified tension band wire. In cases of cerclage wiring, the average time of union was 12-14 weeks. The results of cases treated with tension band wiring are excellent in 40% of cases, good in 50% of cases and poor in 10% of cases. In cases of cerclage wire, excellent results were found in 20% of cases, good in 60% and poor in 20% of cases. Quadriceps wasting was seen in all the cases. In modified tension band wiring, 1-10 mm in 50%, 11-20 mm in 40% of cases and 21-30 mm in 10% cases. In cerclage wiring, 1-10 mm in 20% cases, 11-20 mm in 80% cases and no case showed quadricep wasting of more than 20 mm. Quadricep power was reduced to grade-IV in 20% of cases in modified TBW group and 30% in cerclage wire group. Rest of cases had near normal quadriceps power. In modified tension band wiring, 40% of cases showed full range of movement, 30% showed more than 120º of flexion and 30% showed flexion between 90-120º.

In cerclage wire, 30% of cases showed full movement, 30% above 120º flexion and 40% showed flexion between 90-120º. Gaining range of movements was faster in cases treated with tension band wiring because of better fixation and start of knee mobilization after 2 weeks compared to 4 weeks in cases of cerclage wiring. Quadriceps atrophy may also have occurred because of this longer period of immobilization in cerclage wiring. Extensor lag was seen in 20% of cases treated with cerclage wire and 10% of cases treated with modified tension band wiring. The overall results show that modified tension band wiring is better than cerclage

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wiring. This comparison is done in very small sample so it needs to be done in larger group of patients and with longer follow-up period to conclude better.

Conclusion

Patella is essential for effective function of quadriceps and for proper biomechanics of knee joint so it should be preserved wherever possible. Careful selection of cases and good surgical technique is essential for a good functional outcome in fractures of patella. Place for conservative treatment is only in undisplaced fractures. Operative treatment is essential to carry out repair of the torn expansion of quadriceps and gives good results. Patellectomy leads to quadriceps atrophy, loss of power and extensor lag. Post operative immobilization and physiotherapy plays a vital role. Open grade-I compound transverse fracture should be treated with internal fixation and the disability period should be lessened so that patient could return to work earlier. The modified tension band wiring is better than that of cerclage wiring in transverse fractures of patella probably because of good stability of implant and easier postoperative rehabilitation. Study should be conducted in larger group and more long-term follow-up is needed.

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