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Original Research Article

A comparative study of tension band wiring versus circumferential wiring in the management of patellar fractures

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ABSTRACT

Introduction: Patellar fractures constitute about 1% of all skeletal injuries resulting from either direct or indirect trauma. The subcutaneous location of the patella makes it vulnerable to direct trauma, whereas violent contraction of the quadriceps results in indirect fractures of the patella. Any improper and inadequate treatment would inevitably lead to a great deal of disability which would be most perceptibly felt in a country like India, where squatting is an important activity in daily life.

Materials and Methods: This prospective study was carried out at the Department of Orthopaedics, KBNIMS, Kalaburagi. In this study, 40 patients(23 males and 17 females; mean age 42.7 years) with Patellar fractures were admitted at Khaja Banda Nawaz Institute of Medical Sciences Hospital, Kalaburagi and examined according to protocol. Associated injuries were noted. Clinical and radiological investigations were carried out to get fitness for surgery. Patients underwent Tension Band Wiring or Circumferential Wiring for the sustained fracture. Patients were followed up at 4 weeks, 8 weeks, 12 weeks till fracture union and once at 1 year after surgery using Reich and Rosenberg criteria.

Results: There was no significant difference regarding the mean age, gender, and mechanism of the fractures in patients treated by two methods of TBW and CW. 1 case of superficial infection and 3 cases of joint stiffness were noted after CW and 1 case of superficial infection and 2 cases of joint stiffness had occurred after TBW. 60% excellent, 25% good, 5% fair and 10% poor results were observed after Circumferential Wiring and 65% excellent, 15% good, 15% fair and 5% poor results after TBW. Patients of both groups showed an appreciable and statistically significant improvement in functional outcome at 3 months follow-up period as evidenced by Reich and Rosenberg Criteria that reveals no major difference. Furthermore, the difference in improvement between the two groups was not statistically significant at 3months.

Conclusion: Our findings have shown that Circumferential Wiring and Tension Band Wiring have significantly good to excellent results in the management of fractures of patella. Depending on the categorization of fracture pattern and type, an individual operative plan is proposed.

1. Introduction

The patella is the largest sesamoid bone; it is embedded in the quadriceps tendon, provides the mechanical advantage and leverage that increases the force of knee extension. Tensile forces are transmitted from the lquadriceps to the tibia via the patella, the patella is also subjected to compressive forces at the articulation with the femur. These tensile forces change during movements maximally occuring during flexion of 40 to 60^o, while climbing stairs it increases to 3.3 times of the body weight and while squatting it increases upto 7.6 times.[1]

Patellar fractures are common and it constitutes about 1% of all skeletal injuries resulting from either direct or indirect trauma. As the patella is present subcutaneously, it is more prone for fractures through direct trauma and through indirect trauma by quadriceps contracting violently. Any improper and inadequate treatment would inevitably lead to

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a great deal of disability which would be most perceptibly felt in a country like India, where squatting is an important activity in daily life. Controversy exists regarding treatment of patellar fracture since the earliest time. Conservative treatment is done if patellar fractures are displaced less than 3mm. Of all surgical management of patellar fractures such as modified tension band wiring (TBW), cerclage wiring, screw fixation, plating, and partial or total patellectomy, cerclage wiring and TBW are popular.[2]

Tension band wiring (TBW) technique, one of the most commonly used surgical methods in treating a tension fracture, has a sound biomechanical advantage such that it can convert a tensile force into a compressive force when the joint is brought through a range of motion. TBW results in good fixation leading to early mobilization and also prevents stiffness. Severe complications are rare and implant failure rate is very low. Therefore, we consider that TBW is the gold standard for transverse patella fractures.[3]

Percutaneous cerclage wiring for patella fracture can be applied through several small skin incisions without dissecting the fractured region and surrounding soft tissues and provides a minimally invasive approach to this procedure. The advantage of this is that early range of motion can be started post surgery as the wire fixation also includes the soft tissue.[4]

In our study, we chose to compare the techniques of TBW and circumferential wiring, even though their principles are different as, in circumferential wiring, fixation involves only the soft tissue, so less hardware problems are present, less damage to the surrounding structures and patient can start early mobilization. TBW provides more rigid fixation.

2. Materials and Methods

A prospective study of 40 patients with Patellar fractures, satisfying the inclusion criteria, and treated with either Circumferential Wiring or TBW, was conducted during the period between November 2018 to May 2020 in the Department of Orthopaedics, KBNIMS, Kalaburagi.Patients with patella fractures were divided into two groups of 20 each. Group A was treated using Tension band wiring and the Group B was treated using Circumferential wiring. Inclusion criteria was patients above 18 years age, fresh and old fractures of Patella and either sex. Patients excluded were those with infected fractures and below 18 years age.

After obtaining institutional ethics committee clearance and written informed consent, patients attending the OPD of Orthopaedics department, satisfying the inclusion/ exclusion criteria, were enrolled in the study. Patient was admitted with detailed history and examination, necessary investigations for surgery were done and diagnosis was established by the required radiographs.

Then splinting of fractures was done with the above knee POP slab for patellar fractures. Written and informed consent was obtained. Preoperative intravenous cephalosporin antibiotics were given and continued at 12 hourly intervals postoperatively for five days and then switched to oral form till suture removal.

Then the patients were allocated into two groups by simple random sampling technique, i.e group A & group B. Group A was treated using Tension band wiring and the Group B was treated using Circumferential wiring.

Patients were followed up at 4 weeks, 8 weeks, 16 weeks and at 6 month till fracture union and once at 1 year after surgery using Reich and Rosenberg (1954) scale for Patella fracture.

Table 1: Reich and Rosenberg(1954) scale for patella fracture

Results	Pain	Movement
Excellent	No pain or occasional	No limitation
Good	Pain on prolonged activity	Limitation of 10^0-20^0 of flexion
Fair	Pain while climbing or during work	Flexion > 75^0
Poor	Constant pain	Flexion <75^0

2.1. Operative technique

Spinal anaesthesia was given for surgery of patellar fracture considering the patient's condition. Patient was positioned supine in patella fractures. Pneumatic tourniquet was applied to the thigh in patellar fracture. Affected part was scrubbed, painted and draped.

2.2. Technique of open reduction with TBW

A midline longitudinal incision approximately 12.5 cms long was taken. The skin and subcutaneous tissue were reflected medially and laterally to expose the anterior surface of patella. He fracture surface was examined and blood clots and fragments were removed. Thorough lavage was given. Fracture fragments were reduced anatomically with towel clips or bone holding forceps restoring smooth articular surfaces. 2 mm Kirschner wires were drilled from inferior to superior parallel to each other. These wires were placed 5 mm deep to anterior surface and protruding beyond the patella and quadriceps tendon attachments to the inferior and superior fragments. An 18G SS wire was passed in a figure of 8 manner through the tendon of quadriceps deep to the K-wires and tightened. The articular surface of patella was checked for congruity. The protruding K-wires were bent, cut and embedded in the soft tissue. The retinaculum was sutured and wound closed layers.

2.3. Technique of ORIF with circumferential wiring

After a similar exposure and reduction of fracture, an 18G SS wire was passed through the superolateral border of patella through the tendon of quadriceps. Then it was further passed through the medial border of the fragments, then transversely to the lateral side and finally back to the superolateral side. Fracture was reduced and wire tightened. Undersurface of patella was checked. Extra wire was bent and twisted ends were cut and buried in the soft tissue. The retinaculum was repaired and wound was closed in layers.

After surgery, the limb was placed in extension in a posterior splint or cast. Isometric exercises were started on the first postoperative day. Check dressing was done on 2nd postoperative day to know condition of operative wound. Check X-ray of knee in AP and lateral views were done. Active exercises were started after 2 weeks when the wound was healed. Suture removal was done on 14th postoperative day. Weight bearing was started after 6 weeks.

Follow up was done on OPD basis at 4th, 8th and 12th week postoperatively with clinical and radiological evaluation and using Reich and Rosenberg Criteria.

3. Results

Patients with patella fractures were divided into two groups of 20 each. Group A was treated using circumferential wiring and the Group B was treated using Tension band wiring.

Statistical data was analyzed by using IBM SPSS 20.0 version software. For qualitative data analysis chi-square test was applied, for quantitative data analysis unpaired t-test and ANOVA tests were applied for statistical significance. If P-value

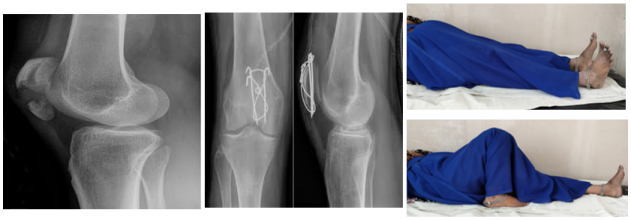

Fig. 1: (a): Pre-operative X-ray showing transverse patella fracture; **(b):** Post-operative X-ray showing ORIF with TBW; **(c)** and **(d):** showing post operative range of movements at 16 weeks was less than 0.05 was considered as statistically significant

The observations made during the course of the study were as follows. Maximum number of patients in both the groups 13 (32.5%) belonged to the age group of 51-60 followed by 10 (25%) and 10 (25%) belonged to the age groups of 41-50 and 31-40 respectively and 7(17.5) patients were in the age group 21-30. Male patients were 23 (57.5%), female patients were 17 (42.5%), patients with right sided fracture were more 22 (55%) in both groups A and B, patients with left sided fracture were 18 (45%). Fracture of patella cases by indirect mechanism of injury were more 22 (55.0%), than by indirect mechanism 18 (45%). Mode of injury which was domestic in nature were more 17(42.5%), RTA were 16(40%), by assault was 3(7.5%) and by sports were 4(10%). Transverse fracture of patella cases were more 24 (60.0%), Comminuted fracture and Oblique fracture patella patients were 8 (20%) and 8 (20%) respectively. Study reveals that 24 (60.0%) of patients had radiological union by 8 weeks, 6(15%) patients by 9 weeks, 7 patients (17.5%) by 10 weeks and 03(7.5%) patients by 12 weeks. The interval between injury and surgery was within 48 hours in 30(75%) patients, from 2-10 days (17.5%) patients and after more than 10 days in 3 patients. Maximum number of patients 29(72.5%) had postoperative pain at 4 weeks, while 7(17.5) had persistent pain at 8 weeks and only 4(10%) had persistent pain at 12 weeks. By 12 weeks 31(77.5%) patients had a full range of movements. By 12 weeks 5(12.5%) patients had joint stiffness and 2(5%) patients had superficial infection with 3 cases of joint stiffness after CW and 2 cases after TBW, whereas 1 case of superficial infection after each CW and TBW. But there was no significant difference between the groups A and B.

Table 2: Distribution of patients according to complications

Complications	Group A No.	Group B No.	Total No.
Joint Stiffness	3	2	5
Superficial skin infection	1	1	2
Deep Infection	-	-	-
Migration of K-wire	-	-	-
Total	4	3	7

Study observes that, by 12 weeks 31(77.5%) patients had full range of movements. But there was no significant difference between the groups A and B.

Results were done according to criteria outlined in the methodology. In our study, excellent results were obtained in by 12(60%) patients in Group A and 13(65%) in Group B. In total of 40 cases, 25 (62.5%) had excellent results, 8 (20%) had good results, 4 (10%) had fair and 3(7.5%) had poor results.

4. Discussion

The treatment of fracture of patella may be either operative or nonoperative but in most reports non operative treatment has been limited to fracture that show intact quadriceps mechanism less than 2 millimetres of separation and without significant displacement of articular surface.

There are many surgical techniques for open reduction and internal fixation of transverse fracture of patella but at the degree of 90° of flexion of knee joint articular surface

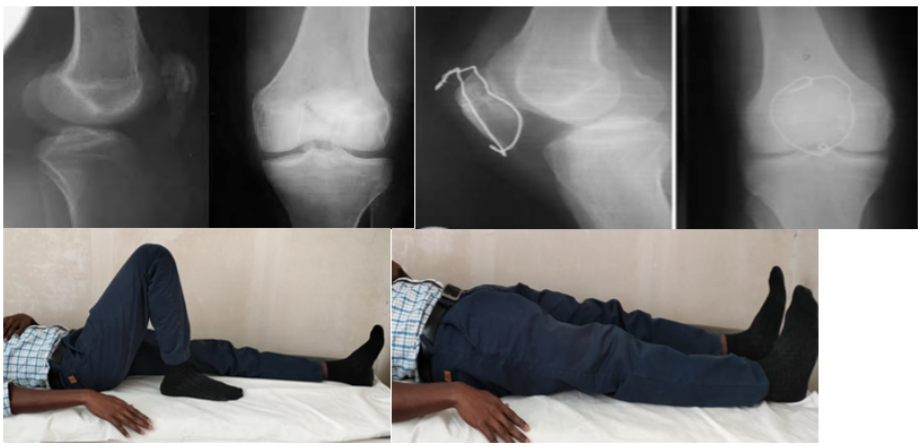

Fig. 2: (a) Preoperative X Ray showing patella fracture; **(b):** Postoperative X Ray showing ORIF with CW; **(c):** Post-operative ROM at 16 weeks

Table 3: Distribution of patients according to post-operative ROM of patella

Gender	ROM	Group A No.	Group B No.	Total No.
4 weeks	No restriction	-	-	-
	Restriction of last 10^0-20^0	7	8	25
	Restriction of 20^0-50^0	7	6	13
	Restriction >50^0	6	6	12
8 weeks	No restriction	7	8	15
	Restriction of last 10^0-20^0	5	5	10
	Restriction of 20^0-50^0	4	3	7
	Restriction >50^0	4	4	8
12 weeks	No restriction	15	16	31
	Restriction of last 10^0-20^0	2	2	4
	Restriction of 20^0-50^0	1	-	1
	Restriction >50^0	2	2	4
Total		20	20	40

Table 4: Distribution of patients and evaluation of results by Reich and Rosenberg scale

Results	Group A No.	Group B No.	Total No.
Excellent	12	13	25
Good	5	3	8
Fair	1	3	4
Poor	2	1	3
Total	20	20	40

was distracted by posterior angulation of fracture fragment (Weber et al. 1980).[5,6]

But after application of tension band wiring technique chances in the articular surface distraction are not seen and early mobilization can be started as noted by Weber 1980,[5,6] B. Levak et al. 1985.[7] Tensile forces of quadriceps are converted to compressive force by anteriorly placed wire.

We used Tension Band Wiring in 20 cases and Circumferential wiring in 20 cases. It has given favorable results in our experience. The average age in the present series was found to be 42.67 years which is in accordance with series Maini and Kochar[8] which was 35.7 years and Bostman[9] which was 42 years. In the present study, fracture incidences are more in males (57.5%) than females (42.5%). Similar sex incidence was found in study made by Al-Sudani,[1] Mohapatra.[2] This indicates that males are more exposed to trauma. The right side (55%) was involved more than the left side (45%). Other series (Maini and Kochar, Mehdi[10] have reported higher incidence of fracture on the right side. It may be due to the fact that the right dominant

side is more vulnerable for trauma.

Indirect trauma was more common in our study (55%), the common mode of injury being domestic in nature. Transverse fractures (60%) were more common in present study, indicating indirect trauma and transverse fractures go hand in hand most of time. In the present study related to tension band wiring, we noted difficulty in maintaining reduction of fragments while introducing "K" wires, passing K wires through bone, soft tissue, bending ends of K-wires.

After 12 weeks 4 (13.33%) cases had restriction of movements upto 20^0. It was due to late seeking of medical advice, migration of K wires, superficial infection and periarticular adhesions as also seen in the study by Dudani and Sacheti.[11]

In our series, we noted superficial infection in one case of patient with TBW and one case with Circumferential wiring (5%), joint stiffness in three cases of TBW and 2 cases treated with circumferential wiring (12.5%) which was similar to the study conducted by Al-Sudani.[1]

According to Reich and Rosenberg Scale criteria outlined in methodology, in the total of 40 cases, 25 (62.5%) had excellent results, 8 (20%) had good results, 4(10%) had fair and poor result is 3(7.5%). Majority of our patients were satisfied with the range of motion gained particularly necessary for the oriental habits of squatting and sitting cross-legged. Similar results were seen in a study conducted by Maini and Kochar and Mohapatra with 36.6% and 50% of excellent results, 38.4% and 30% of good results respectively.

5. Conclusion

It was concluded from the present study that tension band wiring by principle overcomes the distractive force and Circumferential wiring achieves compression at the fracture site and maintains the alignment by minimum hardware. By achieving compression at the fracture site, the fracture heals faster and complications due to prolonged immobilization can be avoided. Therefore, both TBW and CW are simple and affordable options. Similar rate of post-operative complications were seen in both the groups. Both the groups had an almost same functional outcome in both short and long term. It is on the surgeon's preference and the technique chosen should be tailored based on each patient's requirement.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that there is no conflict of interest.

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