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Original Research Article

A Comparative Analysis of Circumferential Wiring and Tension Band Wiring in Patellar Fractures Treatment

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Abstract:

Objectives: The study aims to compare the effectiveness of Tension Band Wiring (TBW) and Circumferential Wiring (CW) for the treatment of patellar fractures. It focuses on evaluating postoperative complications, range of motion, and functional outcomes to provide insights into the success of these surgical techniques.

Methods: The present study took place in the department of orthopaedics at a tertiary care centre in Bihar, India and employed a prospective design with 80 patients having patellar fractures treated using either Tension Band Wiring (TBW) or Circumferential Wiring (CW). Outcomes, including post-surgical complications and outcome measures, were assessed to compare the efficacy of these surgical techniques.

Results: The study revealed that after 12 weeks, 8 cases (13.33 %) exhibited movement restrictions up to 20 degrees. Superficial infection occurred in 5 % of cases treated with both Tension Band Wiring (TBW) and Circumferential Wiring (CW). 6 patients treated using TBW and 4 patients treated using CW showed signs of joint stiffness. These findings suggest similar postoperative complications between the two techniques. In addition, the limitations in range of motion were attributed to factors such as delayed medical consultation, K-wire migration, superficial infection, and periarticular adhesions.

Conclusion: The study demonstrates that both Tension Band Wiring (TBW) and Circumferential Wiring (CW) offer comparable outcomes in the management of patellar fractures. The choice between these techniques can be based on the surgeon's preference, as both exhibit similar rates of postoperative complications and functional results in the immediate and extended period.

Keywords: Patellar fractures, Tension Band Wiring, Circumferential Wiring, Post-surgical complications

Introduction

The patella, being the most prominent ossified nodule, is situated within the extensor mechanism tendon, playing a crucial role in enhancing mechanical advantage and leverage for enhanced knee stretching force [1]. Straining forces from the rectus femoris to the shin bone through the patella, encounter strong forces at the femur articulation. These forces vary during motion, reaching their peak during flexion between 40-60 degrees. Notably, during stair climbing, forces amplify to 3.3 times the weight of the body, and during squatting, they surge to a significant 7.6 times [1, 2].

Fractures of the kneecap, constituting approximately 1 % of bone injuries, arise from implicit or explicit trauma. Due to its subcutaneous location, the patella is prone to fractures through explicit impact and implicit trauma from forceful rectus femoris contraction. Lack of proper treatment results in substantial disability, particularly impactful in cultures like India, where squatting is a common daily practice [3]. The debate over patellar fracture treatment dates back to ancient times, with traditional therapies favoured for fractures with displacement less than 3mm [2, 4].

Various surgical methods are available for managing these fractures, including cerclage wiring, modified tension band wiring (TBW), plating, fixation of screws, as well as total or partial patellectomy [5]. Among these, cerclage wiring and TBW stand out on account of their added advantages. TBW, a widely utilized technique, boasts significant structural advantages, converting stretching forces into compressive forces during joint movement [5, 6]. This ensures stable fixation, facilitates early motility, and prevents rigidity. Complications are infrequent, and the failure rate of the implants are minimal, establishing TBW as the gold standard for transverse patella fractures [7].

Minimally invasive circumferential wiring, an alternative approach, involves tiny incisions on the skin with no dissection of the fractured area and nearby tissues, presenting a better option. This technique enables quick recovery and swift mobility

after operation, as this includes the connective tissue [6, 8].

The current study compares TBW and circumferential wiring techniques employed for the treatment of patellar fractures. Despite differing principles, the latter exclusively involves only soft tissue fixation, resulting in fewer clinical issues, minimal damage to nearby structures, and facilitating early patient motility. In contrast, TBW provides a sturdy fixation. The present comparative analysis aims to contribute valuable insights into the efficacy of these distinct approaches for patellar fracture management.

Methods

In the Orthopaedics Department of a tertiary care centre in Bihar, India, a prospective study was undertaken for 2 years, involving 80 patients with patellar fractures who met specific criteria. These individuals, bifurcated into groups of 40 each, received treatment with either Circumferential Wiring or TBW. The patients belonging to Group A underwent Tension Band Wiring, while those from Group B were subjected to Circumferential Wiring. The study included individuals aged 18 and above with both recent and old patellar fractures, irrespective of gender, while excluding those under 18 years of age and with infected fractures.

The individuals visiting the Orthopaedics department's outpatient clinic and who meet the specified inclusion/exclusion prerequisites were considered to be the participants for this investigation. Upon admission, all the patients underwent a comprehensive history and examination. Essential pre-surgical investigations were conducted, and the diagnosis was confirmed through the necessary radiographs.

Surgical Procedure

The patient's medical condition was initially investigated thoroughly and spinal anaesthesia was administered before commencement of the patellar fracture surgery. The patient assumed a horizontal position for the treatment. An air compression tourniquet was utilized on the thigh during the patellar fracture procedure. The affected area underwent scrubbing, painting, and draping.

Open Reduction of the Fracture using Tension Band Wiring

A midline incision, measuring around 12.5 centimetres, was made to expose the frontal area of the patella. Following the exposure, careful examination revealed the presence of fragments and blood clots, prompting their removal. Anatomical reduction of the fracture fragments was achieved using towel clips and 2 mm Kirschner wires, strategically placed from lower to upper positions. The rectus femoris tendon was secured with a stainless steel (SS) wire threaded in an alternating loop pattern, ensuring stability. After confirming the congruity of the patellar articular surface, the K-wires were appropriately bent, by cutting and embedding them in the nearby connective tissue. Finally, the tendon sheath was sutured, and the incision was closed in layers.

Open Reduction of Fracture using ORIF with Circumferential Wiring

Following the same protocol for fracture reduction, an 18G stainless steel wire was inserted through the posterolateral edge of the kneecap via rectus femoris tendon. It continued through the central boundary of the fragments to the outer side, and ultimately to the same side. The fracture crack was diminished, and the wire was strung tightly. The surface beneath the patellar was inspected, any excess wire was twisted and cut before burying within the nearby tissue. The tendon sheath was then refixed, and the incision closed in layers.

Post-operation, the operated leg was extended using a dorsal cast or splint. Muscle contraction exercises began on the first day after surgery, with a dressing check on the second day to assess the operative wound. Knee X-rays in the lateral and anteroposterior positions were taken. Regular exercises started 2 weeks post-surgery when complete wound healing was observed, and the sutures were removed on the 14^{th} day after surgery. Weight-lifting exercise started after six weeks. Follow-up assessments were scheduled on an outpatient basis at the 4^{th}, 8^{th}, and 12^{th} weeks after surgery, and included radiological and medical evaluations based on the Reich and Rosenberg Criteria.

Statistical Methods

Statistical analysis was carried out using SPSS 20.0 software, employing the chi-square test for qualitative data. Statistical significance of quantitative data was ascertained using ANOVA and unpaired t-test (if P-value < 0.05).

Results

The patient cohort was grouped into two with 40 individuals in each group. Group A underwent treatment with circumferential wiring, while Group B received tension band wiring. Throughout the study, observations revealed that the majority of patients, 32.5%, were in the age group of 50 to 61, followed by 25% in both the 40 to 51 and 30 to 41 age groups, and 17.5% in the 20 to 31 age group. Men constituted 57.5 %, and women accounted for 42.5 % of the patient cohort. Data collected from both groups revealed that right-sided fractures were more prevalent (55%) than left-sided fractures (45%). Fractures caused by an indirect mechanism of injury outnumbered those from a direct mechanism (55 % vs. 45 %). Domestic injuries were

the most common mode (42.5 %), followed by road traffic accidents (RTA) at 40 %, assaults at 7.5 %, and sports-related injuries at 10 %. Angular fractures were the most frequent (60 %), with oblique and splintered fractures each comprising 20%.

Regarding radiological union, 60 % achieved it by 8 weeks, 15 % by 9th week, 17.5 % by 10th week, and 7.5 % by the 12th week. The timeframe between operation and the date of fracture was within 2 days for 75 % of patients, 2 to 10 days for 17.5 %, and > 10 days for 7.5 % of the cohort. At 4 weeks post-surgery, 72.5 % experienced pain, decreasing to 17.5 % at 8 weeks and 10 % at 12 weeks. By 12th week, 77.5 % attained complete mobilization (Table 1).

Table 1: Patients' Post-Operative Range of Motion (ROM) for the Patella

Sex	ROM	Group A (Patient count)	Group B (Patient count)	Total No.
4 weeks	No restriction	-	-	-
	Restriction of 10 to 20 degrees	14	16	30
	Restriction of 20 to 50 degrees	14	12	26
	Restriction greater than 50 degrees	12	12	24
8 weeks	No restriction	14	16	30
	Restriction of 10 to 20 degrees	10	10	20
	Restriction of 20 to 50 degrees	8	6	14
	Restriction greater than 50 degrees	8	8	16
12 weeks	No restriction	30	32	62
	Restriction of 10 to 20 degrees	4	4	8
	Restriction of 20 to 50 degrees	2	-	2
	Restriction greater than 50 degrees	4	4	8
Total		40	40	80

At the 12th week, 12.5 % (10 cases) exhibited joint stiffness and 5 % (4 cases) showed superficial infections (Table 2). Notably, the occurrences of joint stiffness and epidermal infections were distributed between both groups without any statistically significant differences. Results were categorized according to the outlined methodology criteria. In the study, excellent outcomes were achieved in 60 % of Group A and 65 % of Group B, with a total of 62.5 % excellent, 20 % good, 10 % fair, and 7.5 % poor results among the 80 cases.

Table 2: Patients' Distribution Based on Postoperative Complications

Postoperative adverse effects	Group A (%)	Group B (%)	Total
Stiffness of joints	6 (2.4%)	4 (1.6%)	10 (12.5%)
Epidermal infection	2 (0.8%)	2 (0.8%)	4 (5%)
Deep Infection	-	-	-
K-wire migration	-	-	-
Total	8 (3.2%)	6 (2.4%)	14 (5.6%)

Discussion

In addressing patellar fractures, the choice between surgical and non-surgical methods is crucial. Non-surgical approaches are typically limited to fractures with specific characteristics, such as minimal separation and intact quadriceps mechanisms. Various surgical techniques exist for transverse patella fractures, but certain challenges arise, particularly at a 90-degree knee joint flexion, where the articular surface can be distracted due to fracture fragment angulation [8-10].

The TBW technique has demonstrated effectiveness in preventing joint surface displacement, allowing for early mobilization. This technique converts tensile forces from the quadriceps into compressive forces through an anteriorly placed wire [11]. Our study applied both Tension Band Wiring and Circumferential wiring in equal cases, and both techniques showed positive outcomes based on our observations.

Examining demographic aspects, our patient cohort had an average age of 42.67 years, consistent with other studies [11, 12]. Males exhibited a higher incidence of fractures, and the right side was more commonly affected, aligning with existing literature [2]. Indirect trauma, often of domestic origin, was the predominant cause in our study, and transverse fractures were most common, underscoring the association between indirect trauma and this fracture type. However, tension band wiring posed challenges in maintaining fragment reduction during various procedural steps [13].

Post-surgery, complications such as movement restrictions were observed in a small percentage of cases, attributed to factors like delayed medical

attention and wire-related issues. Superficial infections and joint stiffness were also noted but without significant differences between the two wiring techniques. After a 12-week period, movement restrictions up to 20 degrees were observed in four cases (13.33%). This limitation was attributed to delayed medical consultation, K-wire migration, epidermal infection, and tissue rigidity, consistent with findings in the investigation carried out by Dudani and Sancheti [14].

In the current investigation, we identified epidermal infections in two patients treated with Tension Band Wiring (TBW) and two treated with Circumferential wiring (5 %). Additionally, joint rigidity was observed in six TBW patients and four patients treated with circumferential wiring (12.5 %), aligning with consistent findings in Al-Sudani et al [1]. Patient satisfaction, crucial for activities like squatting and cross-legged sitting, was high in our study. This aligns with outcomes seen in similar studies, emphasizing the importance of regaining full movement in patellar fracture management [15, 16].

Conclusion

The study focussing on the comparison of tension band wiring versus circumferential wiring in the management of patellar fractures indicates that TBW effectively addresses the extending force, whereas the latter achieves contraction at the site of fracture with minimal hardware, promoting faster healing and reducing complications from prolonged immobilization. Both tension band wiring and circumferential wiring emerge as simple and cost-effective options, displaying similar rates of postoperative complications and comparable functional outcomes in both immediate and extended period perspectives. The preference of the surgeon preference becomes crucial in selecting the technique, emphasizing the need for tailoring the approach to each patient's individual requirements.

Limitations

The current study's limitations involve a small sample size and absence of a randomized control group, impacting generalizability as well as the ability to make direct comparisons between tension band wiring and circumferential wiring. Caution is advised in interpreting the results, emphasizing the need for more extensive research with robust study designs.

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