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Modified Tension band wiring vs Tension band with cannulated cancellous screws in treating transverse patellar fractures

Paresh Patil

Professor, Department of Orthopaedics, Krishna Institute of Medical Sciences “Deemed to be University”, Karad- 415110, Maharashtra, India.

Nishant Shivade

Senior Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences “Deemed to be University”, Karad- 415110, Maharashtra, India.
Corresponding Author: Nishant Shivade

Mithilesh Nikam

Senior Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences “Deemed to be University”, Karad- 415110, Maharashtra, India

Sandeep Shirahatti

Senior Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences “Deemed to be University”, Karad- 415110, Maharashtra, India.

Abstract---Purpose: Despite being the most favoured modality of treatment in patellar fractures, modified tension band wiring (MTBW) technique has serious demerits with regards to clinical outcomes. Tension band with cannulated cancellous screws (TBCC) is a recent technique to overcome the demerits associated with former technique. This study was aimed to compare these two techniques, in terms of clinical outcomes, in treating patellar fractures. Methods: This hospital based prospective randomized study was conducted in a tertiary care hospital for 2 years. Thirty patients with Gustillo-Anderson grade 1 and 2 compound fractures were randomly divided into two treatment groups, viz MTBW and TBCC groups. After performing pre-operative investigations, patients were anesthetized, and knee was operated by the standard procedures. Post-surgery, radiographs were taken and range of motion, pain score (Visual Analogue Scale (VAS)), time taken for radiological union, clinical outcomes were recorded. Results: Mean age of the patients included in the MTBW and TBCC group were 53 years and 58.5 years, respectively. Between the groups, range of motion, IOWA score assessed at the end of 6 months, did not vary significantly ($P>0.05$). Meanwhile, the difference noticed with average time taken for

radiological union was also nonsignificant (MTBW =11 weeks. TBCC=10 weeks). Significantly a greater number of complications were observed in MTBW group ($P<0.05$). Seven out of 15 patients experienced moderate to severe pain and Implant loosening, hardware migration was observed in three patients of MTBW group. Whereas, no such complications were observed in TBCC treatment. Conclusion: The study results indicated that, TBCC is more effective than MTBW with less complications and better clinical outcomes.

Keywords---Bone screws, Fracture fixation, Knee-joint, Radiography, Range of motion.

Introduction

Transverse fractures accounts nearly 70-90% of all the patella fractures and often requires surgical intervention to restore the extensor mechanism and to help in fracture healing.^[1,2] Open reduction and internal fixation is most favoured modality of treatment of transverse patellar fracture. Modified Tension band wiring (MTBW) technique, one of most preferred surgical technique, would allow an early joint mobilization and prevention of knee stiffness.^[3] Despite its biomechanical advantage in therapeutic success, the complaints due to hardware irritation are common.^[4-6] In addition, post-operative complications like hardware exposure, loss of reduction, early MTBW failure are often observed exposing the alarming need for an alternate approach.^[7]

Recently, Tension band with cannulated cancellous screws (TBCC), an alternate approach, was also followed to treat patellar fractures. This technique provides more rigid fixation and decreased skin irritation, implant loosening as well as improved stability.^[5] Currently, high degree of paucity in comparative research of MTBW and TBCC was observed.^[6] Thus, a prospective randomized controlled trial will be highly useful to evaluate the relative therapeutic advantages of these two patella fixation techniques.

The current CONSORT guidelines based prospective randomized trial was objectified to compare efficiency of MTBW versus TBCC in treating transverse patellar fractures. The study was aimed to determine whether TBCC was associated with improved implant stability, patient compliance, range of motion and radiological union.

Materials and Methods

Trial design and Participants

This hospital based simple randomized study was conducted in the orthopaedics department of a tertiary care hospital, India from 2017 to 2019. After obtaining ethical clearance from the Institutional Review Board the patients were equally assigned to, one of the two surgical treatment groups receiving MTBW and TBCC treatment procedures. Prior to operation, a written informed consent was taken from the patients for surgery and research.

Patients of age 18 years and above, with Gustillo-Anderson grade 1 and 2 compound fractures and having displaced transverse fractures >3mm were included in the study. In addition, patients having fractures with >2mm of articular incongruity and loss of extensor mechanism were also included. Meanwhile, patients with Gustillo-Anderson grade 3 fracture, comminuted fractures and arthritis complications were not considered for the study.

Intervention and outcomes

Patients admitted in the hospital were examined for fractures and diagnosis was confirmed on taking radiographs on anterior-posterior, lateral views. Affected limb was immobilized with cylindrical slab on admission. All the routine pre-operative investigations, fitness for anaesthesia, surgery was performed. 30 mins prior to surgery, single IV dose of ceftriaxone was given to the patients.

Modified Tension Band Wiring (MTBW) Group

The patients were anesthetized, and operative knee was kept in full extension on radiolucent table. Through subcutaneous tissue incised along longitudinal midline, Quadriceps femoris aponeurosis and patellar tendon were confirmed to be adherent to surface of patella. After exposing the fracture site, reduction was achieved using patella holding clamp and two K-wires of size 2mm were drilled parallel to each other from inferior pole to superior pole under fluoroscopic guidance. A stainless-steel wire of size 16G was threaded through both ends of both k-wires, forming a vertical figure of "8", and tension band over anterior surface of patella. Ends of wire and K-wire were buried into peripatellar tissue and closure was performed in layers. Position of hardware, reduction of fracture was verified with the help of fluoroscopy in AP and Lateral views.

Tension band with cannulated cancellous screw (TBCC)

The above-mentioned surgical steps were followed with the exception of drilling of guidewires. They were replaced by the cannulated cancellous screws to form the vertical figure of "8" over anterior surface of patella.

Post-surgery, IV antibiotics was given to both the groups for 3 days. From the post-operative day 1, static quadriceps exercises, straight leg raising exercises, passive range of motion exercises was initiated according to pain tolerance of the patient. Partial weight bearing and full weight bearing were started after 2 weeks and 6 weeks, respectively. Active knee flexion and extension exercises were started after 3 weeks. Post-operative radiographs were taken on day 1, 6 weeks, 3 months and 6 months in AP and lateral views.

Existence of deformity or instability, range of motion, time taken for radiological union were evaluated as primary outcomes. In addition, IOWA knee pain score criteria (Table 1) were also recorded by enquiring joint pain during regular activities. Wasting of quadriceps femori muscle and patient compliance by Visual Analogue Scale (VAS) were also assessed. All the patients were regularly followed up till the end of 6 months or achieving radiological union, whichever was later.

Sample size and randomization

During the study period, 30 patients were recruited for the study and were equally divided into two treatment groups by simple randomization technique.

Statistical analysis

The data was analysed using the R studio version 3.0.6 software. Normally distributed variables were analysed using parametric tests of significance like student's t-test, chi-square test and proportion test at 95% confidence intervals. $P < 0.05$ was considered to be significant.

Results

Mean age of the patients included in the MTBW and TBCC group were 53 ± 9 years and 58.5 ± 9 years, respectively. The ratio of male and female patients was found to be 1.14 in both the groups did not vary significantly.

The range of motion, assessed at the end of 6 months, was represented in the table 2. Nine out of 15 patients from the MTBW group had range of motion $> 120^\circ$ and six patients had $90-120^\circ$ of range of motion. Meanwhile, the same was observed to be 13 and 2 patients respectively, in the TBCC treatment. Their results did not vary significantly ($P > 0.05$). Both the treatment groups required similar time period for radiological union ($P > 0.05$) and did not differ significantly. The difference noticed with respect to VAS Score for pain and the IOWA knee score taken at the end of 6 months was also nonsignificant between the treatment groups.

Whereas, a significant difference ($p < 0.01$) was observed regarding complications involved i.e. patient compliance and therapeutic success. As many as seven patients, who underwent MTBW treatment, had moderate to severe pain during knee movements and experienced intraoperative loss of reduction, which eventually led to malreduction (Figure 3). Implant loosening and hardware migration was also observed in three out of these seven patients, which was later corrected by employing braces. Comparatively, the patients treated with TBCC group experienced less pain during the recovery process and no such complications were observed.

Quadriceps femori muscle wasting was observed in three patients treated with MTBW technique. In addition, three patients of the same group had to shift from their work nature due to the complications faced during the treatment (Table 3). Whereas, none of the patients had those difficulties in the TBCC group. Three patients from MTBW group and one from TBCC group suffered superficial infection during recovery and was treated with IV antibiotics and wound care.

Discussion

Among the plethora of treatment techniques, MTBW exhibit many complications like frequent irritation, high failure rates and poor fracture reduction. [9,10] Employing cannulated cancellous screws with tension band wiring in treating

patellar fractures is a novel technique and was pioneered by Zhang et al. [11] For improved range of motion and radiological union, patella must be resistant to axial and distraction forces. Few researchers observed that MTBW was relatively unstable to withstand these distraction forces and ability to decompress the fracture was also less and restricted the range of movement in patients. [11-13] This phenomenon was observed in the current study also. Baydar et al., reported that cannulated screws are more durable and aids in retaining normal range of motion and union which was mirrored in the current study. [13]

In this study, significant number of patients reported irritation and the complications observed, were in agreement to many clinical studies. [9,10] The mean time required for radiological union and range of movements observed in both the treatment groups was similar to the findings of Khan et al, which was conducted on the Indian population. [14]

The implant loosening and hardware migration was observed with MTBW, this could be attributed to the reason that, tension bonding of steel wire through the sub cutaneous patellar bone could jeopardize blood flow and causes soft tissue damage and infection, eventually resulting implant related complication. [15] We substantiate with other authors in adapting TBCC technique to avoid many of those complications for positive clinical outcomes. [16,17]

Patients of TBCC group did not show loss of fracture reduction, implant migration, or tissue irritation and similar results were substantiated in other clinical findings. [18,19] Improved biomechanical advantage and better patient outcomes were observed in this randomized study. Similar results were observed in the biomechanical study conducted by Zhang et al., who compared TBCC with other techniques and showcased that inclusion of screws yielded better results than the modified tension band. [11] Superficial infections after surgery were commonly observed in the patients of study age group and was reported in other investigations as well. [14] Lin et al reported very low complication rate observed with TBCC technique in comparison to MTBW, which complied with the current study. [20]

Our study had limitations like non-inclusion of comminuted fractures, which indicates the current technique is applicable for transverse patellar fractures only. Moreover, the study was open-label with low sample size. Despite these limitations, important findings were made with respect to the clinical outcomes in treating patellar fractures and recommended that TBCC is a good alternative to the MTBW. Because of the biomechanical advantages of TBCC, the chances of implant migration and reduction failure are low and allows complete range of motion, thus improving therapeutic outcome.

Conclusion

From the results, the tension band with cannulated cancellous screws is more effective than modified tension band wiring with less complications and better clinical outcomes. However, the study should be conducted on larger sample size and longer follow-up periods.

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Table 1: IOWA Knee score

Criteria	Grading
No pain, Range of motion $\geq 135^{\circ}$	Excellent
No pain, Range of motion $\leq 90^{\circ}$ and $\geq 135^{\circ}$	Good
No pain, Range of motion $< 90^{\circ}$ Pain with Range of motion $> 90^{\circ}$	Fair
Pain with Range of motion $> 90^{\circ}$	Poor

Table 2: Comparison of Radiological Union and complications

Parameter	MTBW	TBCC	P-value
Range of Motion			
$> 120^{\circ}$ (n)	9	13	$P > 0.05^c$
$90-120^{\circ}$ (n)	6	2	
Radiological Union (in weeks)	11	10	$P > 0.05^t$
Complications (n)	7	0	$P < 0.05^p$

MTBW= Modified Tension Band Wiring; TBCC=Tension band with cannulated cancellous screw; ^c = chi-square test; ^t = t test. ^p = proportion test

Table 3: Comparison of treatment outcomes

Parameter	MTBW (n)	TBCC (n)	P-value
Visual analogue Score after 6 months			
No pain	10	13	P>0.05 ^c
Minimal pain	3	2	
Moderate pain	2	0	
IOWA Knee score			
Excellent	10	14	P>0.05 ^c
Good	5	1	
Superficial infection	3	1	P>0.05 ^P
Quadriceps Femori muscle wasting	3	0	P>0.05 ^P
Return to same work	12	15	P>0.05 ^P

MTBW= Modified Tension Band Wiring; TBCC=Tension band with cannulated cancellous screw; ^c = chi-square test; ^p = proportion test;



Figure 1: Surgical implantation of CC screws in patellar fracture

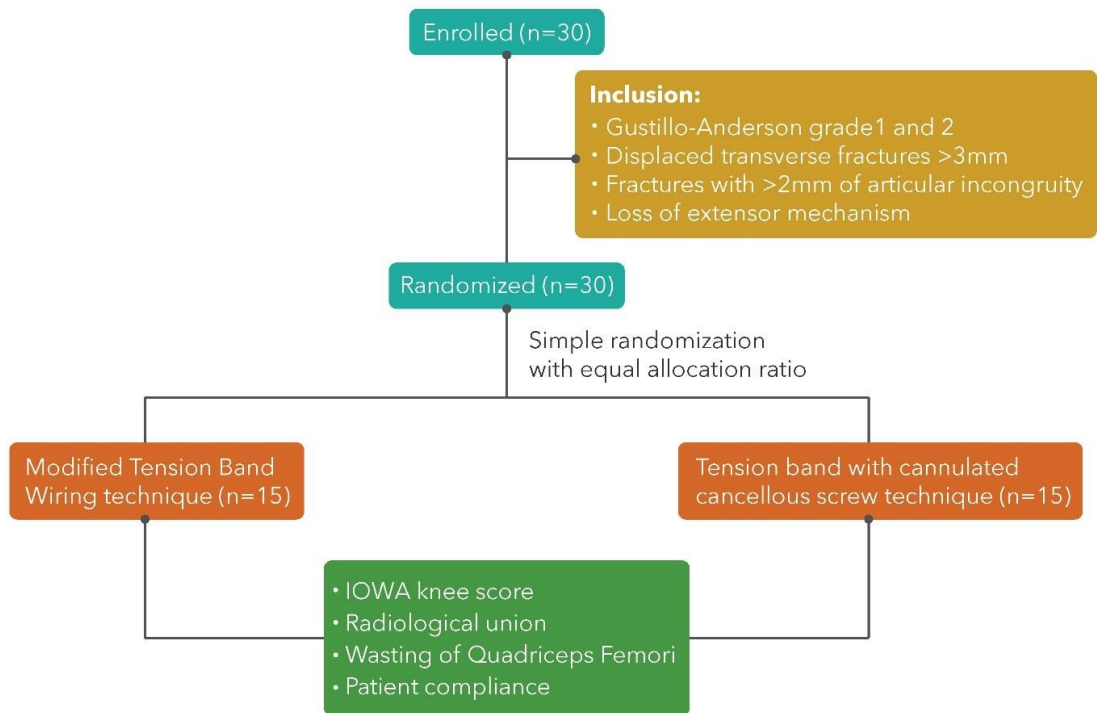


Figure 2: CONSORT diagram

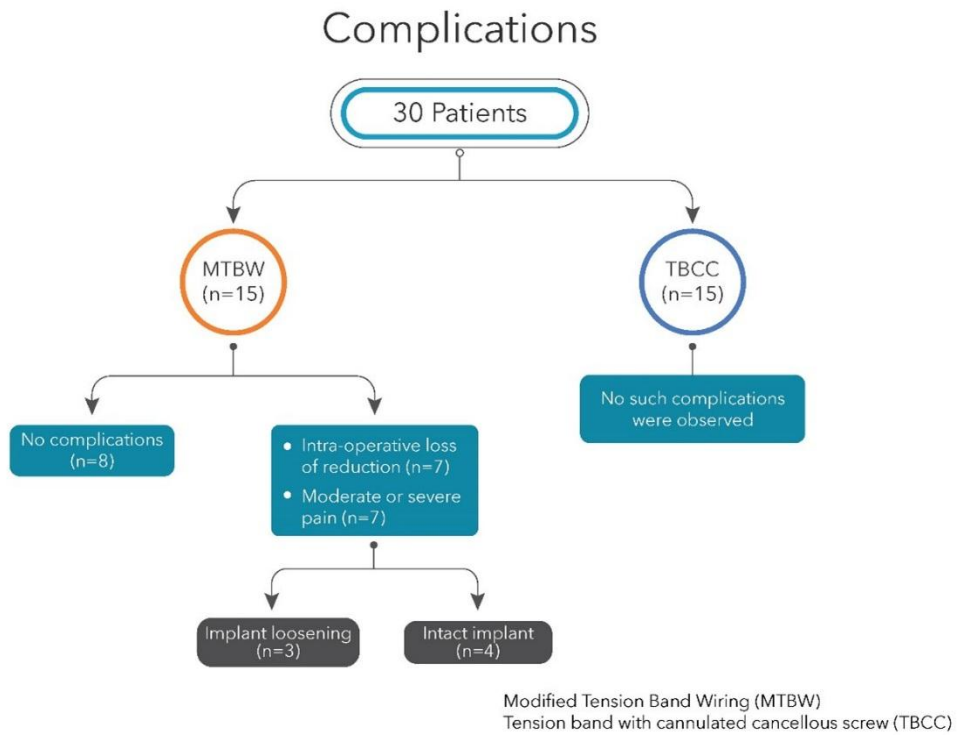


Figure 3: Complications observed in the study population