



TENSION BAND WIRING OF TRANSVERSE FRACTURE PATELLA: STILL STANDS PROUD IN AN ERA OF MULTIMODAL MANAGEMENT TECHNIQUES

Orthopaedics

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ABSTRACT

Introduction: Patella is an important bone of the body with role in knee biomechanics as well as knee joint formation. Displaced fractures need to be reduced meticulously to reconstruct the joint. There are diverse patterns of fracture of patella and at the same time various fixation methods for a single fracture type. Many new techniques have emerged in recent times including screw and wire, plating, etc. Tension Band Wiring (TBW) is a time tested procedure with excellent results. We have conducted this study to further stress the importance of this technique in transverse fracture patella.

Objectives: To study functional outcomes of patients treated with TBW in terms of range of motion, quadriceps strength, time to union.

Study design: Prospective and retrospective observational study.

Material and methods: This was a prospective and retrospective hospital based study of patients with road traffic injuries presenting to orthopaedic emergency department of Dayanand Medical College and Hospital, Ludhiana, India. Data was collected in a predesigned proforma including patient and injury details.

Results: Age group ranged from 22 to 77 years (mean 40.46 years). 73% (n=19) patients were males, similarly 73% (n=19) fractures were on right side. Majority (77%, n=20) were road accident victims. Out of 26 patients that were followed up, six patients had union evident by 10 weeks (n=6; 23.1%). The mean radiographic union time was 12.77 weeks. Twenty two out of twenty six of our patients had no pain (n=22; 84.6%), range of motion more than 90° and final quadriceps strength >75%.

Conclusion: TBW patella is a valuable procedure in transverse displaced fracture patella, is safe, quick and time tested technique with good functional outcomes and lesser complications. With the ready availability of simple instruments and implants, this is a universally gold standard technique for AO type C1 type of fractures of patella.

KEYWORDS

Fracture patella, tension band wiring, knee score

INTRODUCTION:

Patella is the largest of the sesamoid bone of the body in the tendon of quadriceps femoris.^[1] The proximal three-fourths of the patella is covered with thick articular cartilage, while the distal pole is entirely devoid of articular cartilage. For this reason, most distal pole fractures are extra-articular. Fracture of the patella may be associated with intact quadriceps mechanism like in undisplaced fractures but in displaced fractures, it is usually disrupted. So two major reasons for patellar fixation are: first, patella plays a vital role in knee function with proper quadriceps working for knee flexion and extension.^[2,3] Secondly, as large part of the patella is intra-articular, fracture of patella if not meticulously reduced, leads to secondary osteoarthritis of the knee.^[4] Fractures of the patella are approximately 1% of all skeletal fractures.^[5] Injuries follow various patterns e.g. open/close, displaced/undisplaced, direct impact or indirect, domestic fall/fall from height or high energy impact in roadside accidents.

Various techniques of management have emerged over time ranging from conservative methods like cast, elastoplast taping, screw fixation, plating, tension band wiring, etc. But throughout this time of evolution of various methods, Tension Band Wiring (TBW) has stood with heads high and is still considered gold standard in displaced transverse fractures of patella.^[6-13] All positive aspects expected of intra-articular fractures treatment are present in this method like minimal soft-tissue handling, minimal metalwork, early knee motion and weight-bearing, minimal failure rates, minor complications and easy removal if needed.^[14-16] More so, the management of patella fracture was revolutionized with introduction of this technique by AO group^[17] and further modifications^[17,18,19]

The famous principle is that TBW resist the bending loads and convert them into compressive loads, enhancing union at the fracture site. Not only in patella but in various other indications like TBW Olecranon, Medial malleolus, Greater trochanter femur, this technique has yielded good results.

We carried out a prospective study where we included patients who had transverse fractures of patella and were managed with TBW technique only. Purpose of this study is (1) to find out functional outcomes in terms of range of motion, quadriceps strength, time to union, etc. (2) Stressing the fact that TBW is the gold standard treatment in simple displaced transverse fractures of the patella.

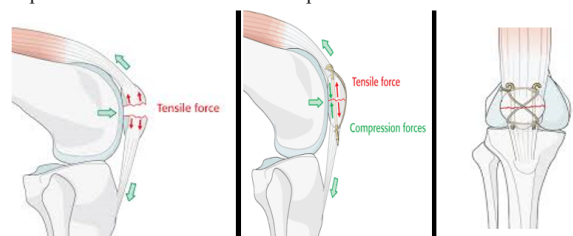


Figure 1: Principle of tension band wire fixation

MATERIAL AND METHODS:

This is a prospective and retrospective observational study done at Dayanand Medical College and hospital, Ludhiana, Punjab, India after approval from Institutional ethics committee. We included consecutive patients who came with fracture patella and treated with tension band wiring technique. A total of 27 patients of transverse fracture patella were treated by this method during a 2 year period from June 2014 to May 2016. Only adult patients (age >18 years) with isolated patella fracture in the lower extremity and treated with TBW technique were included in this study. One patient was excluded as he had a refracture due to fall after 3 months of surgery. So the final data consisted of 26 patients. The exclusion criteria were the patients with associated fracture of the contra-lateral lower limb, receiving any other form of treatment for patella fracture and minimally displaced fracture with intact quadriceps mechanism. Patella fractures were classified according to AO/OTA classification as 34 A/B/C and further sub-classified according to fracture pattern.

Management protocol:

Patients were clinically assessed in the emergency room by a resident and consultant immediately after the patient presents, according to institutional trauma care guidelines followed by radiographs of the involved side. A plan was constructed for fixation surgery after resuscitation. Those patients who fit into inclusion criteria were selected for the study and written consent was taken. After surgery, regular follow up was done at one-month interval up to six months. Regular X-rays were taken monthly and clinical assessment was done on the basis of which a pre-designed Performa was filled to assess the functional outcome of fracture fixation. The secondary surgical procedure needed, duration and protocol of rehabilitation were also recorded. Results were evaluated according to the Hospital for Special Surgery (knee service) scoring system.

The following equipment was used during the surgical procedures:

- 1.6 mm K-wires
- 18 gauge wire
- Power Drill
- Small and large Pointed reduction clamps
- K-wire bender
- K-wire cutter
- Plier
- Image Intensifier

Surgical technique :

Either general or spinal anaesthesia was given according to the patient's condition. The patient was positioned supine with knee in 30° flexion. Mid-axial longitudinal approach was used in all the patients. Open fractures were debrided first followed by extension of wound superior and inferior to match mid axial longitudinal incision. Two 1.6 mm K wires inserted parallel to each other from proximal to distal pole. An 18 gauge cerclage wire placed in a figure of eight pattern around the k-wires through ligamentous structures and close to patella surface. Two twisted knots were made on each side of patella equidistant from both poles of patella. Distal ends of K wires were bent outwards and buried under soft tissue to prevent impingement. The same technique was used in all the cases.

Postoperative regimen:

Postoperative X-rays were done to document reduction and fixation. Regular physiotherapy was done. On day 1, early weight-bearing as tolerated and isometric and stiff-leg exercises were started. Active range of motion exercises encouraged after 3 weeks and progressive resistance exercises 6-8 weeks post-operative after healing is evident on the radiograph. Unrestricted activity was resumed after full quadriceps strength was gained (18-24weeks).

Follow up:

Patients were followed up in the outpatient department monthly for up to six months. On every visit, local site was examined for any signs of local inflammation or infection, range of motion of knee was assessed, functional status of the patient was documented and X-rays of the involved knee were taken. Radiological union was established when the bony trabeculae crossed the fracture line. Fracture union, alignment of fracture and all long term complications like non-union or infection were recorded. For patients with associated injuries, the rehabilitation program was started under the supervision of a physiotherapist. Secondary surgical procedures were performed as per requirement and have been recorded in the Performa. The duration and physiotherapy programme followed noted. Results were evaluated as per the modified Hospital for Special Surgery (Knee service) scoring system

Table 1: Modified Hospital For Special Surgery (knee Service) Scoring System

VARIABLES:	Feature	Score
Rest pain	Continuous: bed-chair status, narcotics	0
	Intermittent: occasional narcotics	1
	After excessive activity	2
Support Required because of pain	Double support only	10
	Limits excessive walking	15
	Single support only	20
No support required	Limits routine walking	25
	Limits excessive walking	30
	Weather-related ache, starting discomfort	35
	No pain	40

Stability(measured as total Varus-Valgus arc, extension)	00-60	25
	70-90	21
	100-120	17
	130-150	13
	160-180	9
	190-210	5
	>210	0
Motion(measure as a total passive arc)	00-100	0
	110-300	40
	310-500	10
	510-700	15
	710-900	20
>900	25	
Quadriceps strength(measured as 10%of normal for age and gender)	>75%, cannot break quadriceps power	10
	50-74%, can break quadriceps power	5
	<50%, hard to move through an arc of motion	0
Subtractions(extension lag, flexion contracture)	10-150	-4
	160-300	-8
	310-450	-12
	>450	-16
Fixed Varus deformity	+20 to -20	-4
	-30 to -70	-8
	> -70	-12
Fixed Valgus deformity	+20 to +130	-2
	+140 to +180	-4
	>+180	-6
Final score	90-100	Excellent
	80-89	Good
	70-79	Fair
	<70	Poor

RESULTS:

The final data consisted that of 26 patients with age group range from 22 to 77 years (mean 40.46 years). 73% (n=19) patients were males, similarly 73% (n=19) fractures were on right side and rest on left. Majority (77%, n=20) were road accident victims while rest (23 %, n=6) fractures occurred due to fall. 21 patients had closed injuries and only 5 were open. (table 2)

Table 2: Patient variables, injury characteristics and classification of fractures.

Factor		Number (%)
Age group	18-30 years	11 (42)
	31-50 years	6 (23)
	>50years	9 (35)
Gender	Female	7 (27)
	Male	19 (73)
Mode of injury	Fall	6 (23)
	Road side accident	20 (77)
AO classification	34A	0
	34B	0
	34C1.1	18 (69)
	34C1.2	0
	34C1.3	2 (4)
	34C2	1 (4)
	34C3.1	5 (19)
Compounding	Open fracture	5 (19)
	Close fracture	21 (81)

Table3: Distribution of patients according to injury-surgery interval:

TIME DURATION BETWEEN INJURY AND SURGERY	No. of Patients	Percentage of patients
0-1DAY	16	61.5%
2-3 DAY	7	26.9%
MORE THAN 3 DAYS	3	11.5%
Total	26	100.0%

The average injury-surgery interval was around two days in majority (n=16; 61.5%). Polytrauma patient were operated after initial resuscitation and stabilization of general condition.

Out of 26 patients that were followed up, six patients had union evident by 10 weeks (n=6; 23.1%) and 11 patients had union by 12 weeks (n=11; 42.3%). Three patients had union by 14 weeks (n=3; 11.5%)

and rest by 16 weeks (n=6; 23.1%). The mean radiographic union time was 12.77 weeks. None of the observed fractures went to non-union. (figure 2)

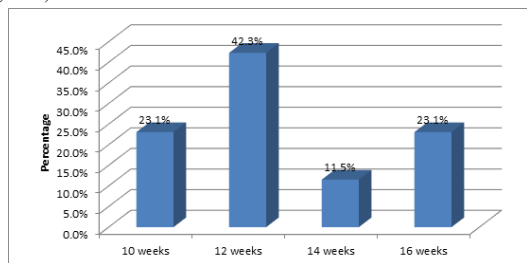


Figure 2: Distribution of patients according to mean time of radiographic union of fracture

Twenty two out of twenty six of our patients had no pain (n=22; 84.6%), range of motion more than 90° and final quadriceps strength >75%. Only four patients had pain, decreased range of motion and quadriceps strength which required no support but their excessive walking is limited, after six months of surgery (n=4; 15.4%). These four patients had associated fractures of ipsilateral lower limb bones (table 4)

Table4: Outcomes of patients in relation to pain, range of motion and final quadriceps strength

Variables	Characteristic	Number(%)
Pain	No pain	22(84.6)
	Require double support	0
	Require single support	0
	Limit excessive walking	4(15.4)
	Limit routine walking	0
Range of motion	11°-30°	0
	50°-70°	0
	71°-90°	4(15.4)
	> 90°	22(84.6)
Quadriceps strength	<50%	0
	50-74%	4(15.4)
	>75%	22(84.6)

DISCUSSION:

The purpose of the current study is to determine the clinical and radiological outcome of TBW of transverse fracture patella and support the time tested technique of tension band wiring by proving the favourable outcomes of this technique.

We found higher prevalence among men in the younger age group(mean age of 40years). Similarly, Sarabjeet Kohli et al^[20] and Sudheendra P.R., Krishna Prasad.S^[21] reported the mean age as 38 and 42 years respectively and incidence in males twice compared to females. This could be attributed to more often involvement in outdoor activities in males and this age group, making them more prone to injuries. Regarding the side of injury, 73% of fractures in our series were located in the right lower limb while Sudheendra P.R, Krishna Prasad.S and Muralidhar BM et al observed the predominance of right side in 60.5% and 70% respectively.^[21,22]

In this study, the mode of injury was road traffic accident in the majority(77%), rest due to fall. This is in contrast to other studies where fall is the major cause of patella fracture.^[21] We classified the transverse fractures according to AO classification and found that majority were of type C1(transverse simple)- 77% and out of all simple transverse types(20), 18 were type C1.1(simple transverse middle third). The higher number of this type of fractures is in concordance to findings of other researchers.^[21,22]

The earliest signs of union and mean union time in our study were 6weeks and 13 weeks, respectively. About 65% of the fractures united in 12 weeks time. There was no non-union in our study. Gangadhara Reddy Kota et al reported that the mean time of fracture union as 14 weeks.^[23]

No major complication was seen in any case for the time period we followed up (six months). Five patients had metalwork impingement after union for which metalwork removal was done (19%). Rate of hardware removal in different studies were 37-52%.^[24,25] Only one patient with open grade 2 fracture to start with had a superficial

infection of the operated wound and managed conservatively with antibiotics and regular antiseptic dressings. In studies by Muralidhar BM et al, one case of superficial infection and in the study by Srinivas er al, no case of infection was noted. Phieffer^[26] reported a high incidence of patella-femoral osteoarthritis as a complication of the fractured patella. We noted in our study four cases with early patella-femoral osteoarthritis. These were present pre-operatively. In only one of these cases, the outcome was significantly affected while the other three patients were able to cope up despite the problem. We agree with Phieffer^[26] that a longer duration follow-up is necessary for a valid conclusion on this aspect.

Out of 26 patients under study here, 22 patients had no pain at the final outcome at 6 months, range of motion was excellent (>90°) in 85% patients and Quadriceps strength was >75% in 85% patients.

From this data of outcome variables, we can safely conclude that tension band wiring technique for transverse displaced fracture patella, is safe, quick and time tested technique with good functional outcomes and lesser complications. Other newer techniques might be proving to be good in these kinds of fractures, but that doesn't overshadow the importance of this technique. With the ready availability of simple instruments and implants, this is a universally gold standard technique for AO type C1 type of fractures of patella. The limitation of this technique is in comminuted type of fractures or stellate type where other methods may be used along with pin and wire technique.

REFERENCES:

- O'Donoghue DH, Tompkins F, Hays MB. Strength of quadriceps functions after patellectomy. West J Surg Obstet Gynecol. 1952;60(4):159-67
- Yamaguchi GT, Zajac FE. A planar model of the knee joint to characterize the knee extensor mechanism. J Biomech. 1989;22(1):1-10.
- Greisamer RP, Weinstein H. Applied biomechanics of the patella. Clin Orthop Relat Res. 2001;389:9-14.
- Brooke R. The treatment of fractured patella by excision. A study of morphology and function. Br J Surg. 1937;24:733-47
- Boström A. Fracture of the patella. A study of 422 patellar fractures. Acta Orthop Scand.1972;143(suppl):1-80.
- Melvin JS, Metha S. Patellar fractures in adults. J Am Acad Orthop Surg. 2011;19(4):198-207
- Mao N, Ni H, Ding W, Zhu X, Bai Y, Wang C, et al. Surgical treatment of transverse patella fractures by the cable pin system with a minimally invasive technique. J Trauma Acute Care Surg. 2012;72(4):1056-61
- Hung LK, Chan KM, Chow YN, Leung PC. Fractured patella: operative treatment using the tension band principle. Injury. 1985;16(5):343-7.
- Weber MJ, Janecki CJ, McLeod P, Nelson CL, Thompson JA. Efficacy of various forms of fixation of transverse fractures of the patella. J Bone Joint Surg Am. 1980;62(2):215-20
- Lotke PA, Ecker ML. Transverse fractures of the patella. Clin Orthop Relat Res. 1981;158:180-4.
- Wu CC, Tai CL, Chen WJ. Patellar tension band wiring: a revised technique. Arch Orthop Trauma Surg. 2001;121(1-2):12-6.
- Hoshino CM, Tran W, Tiberi JV, Black MH, Li BH, Gold SM, et al. Complications following tension-band fixation of patellar fractures with cannulated screws compared with Kirschner wire. J Bone Joint Surg Am. 2013;95(7):653-9.
- Taylor BC, Mehta S, Castaneda J, French BG, Blanchard C. Plating of patella fractures: techniques and outcomes. J Orthop Trauma. 2014;28(9):e231-5
- Lotke PA, Ecker ML. Transverse fractures of the patella. Clin Orthop Relat Res. 1981;158:180-4.
- Wu CC, Tai CL, Chen WJ. Patellar tension band wiring: a revised technique. Arch Orthop Trauma Surg. 2001;121(1-2):12-6.
- Hoshino CM, Tran W, Tiberi JV, Black MH, Li BH, Gold SM, et al. Complications following tension-band fixation of patellar fractures with cannulated screws compared with Kirschner wire. J Bone Joint Surg Am. 2013;95(7):653-9
- Muller ME, Allgower M, Schneider R, Willinger H. Manual of Internal Fixation: Techniques Recommended by the AO Group. Berlin: Springer-Verlag; 1979:248-253
- Weber MJ, Janecki CJ, McLeod P, Nelson CL, Thompson JA. Efficacy of various forms of fixation of transverse fractures of the patella. J Bone Joint Surg Am 1980;62(2):215-220
- Hung LK, Chan KM, Chow YN, Leung PC. Fractured patella: operative treatment using the tension band principle. Injury 1985; 16(5):343-347
- Sarabjeet Kohli, Nilesh Vishwakarma, Varun Joshi, Shaival Chauhan, Kuldip Salgotra, Siddhant Jain, et al. A Prospective Study of Patellar Fracture Complications. Sch J App Med Sci. 2016;4(6B):1997-2002.
- Sudheendra Krishnaprasad PR. Functional outcome of patellar fractures treated by internal fixation: a retrospective study. Journal of Evolution of Medical and Dental Sciences. 2014;3(29):8126-41.
- Muralidhar BM, Madhusudan H and Mithun Mohan. Study of patellar fractures treated by modified tension band wiring—A prospective study. IJOS. 2017;3(2):864-71
- Kota GR, Vamshi D. Patellar Fractures Treated by Modified Tension Band Wiring: A Clinical Study in a Teaching Hospitals. Ann Int Med Den Res. 2016;2(1):142-5.
- LeBrun CT, Langford JR, Sagi HC. Functional outcomes after operatively treated patella fractures. J Orthop Trauma. 2012;26(7):422-6.
- Hoshino CM, Tran W, Tiberi JV, Black M.H, Li B.H, Gold S.M, et al. Complications following tension-band fixation of patellar fractures with cannulated screws compared with kirschner wires. J Bone Joint Surg Am. 2013;95(7):653-9.
- Phieffer LS, Kyle RR. Treatment of patellar fractures. Techniques in knee surgery. 2003;2(3):153-9.