COMPARATIVE STUDY BETWEEN TENSION BAND WIRING OF PATELLAR FRACTURES WITH KIRSCHNER WIRES AND CANNULATED SCREWS IN TERMS OF FUNCTIONAL OUTCOME AND COMPLICATIONS

Kumaran Chettiar[1], Muhammed Rafi M[2]

[1]Additional Professor, Department of Orthopaedics, Government Medical College, Manjeri.
[2]Senior Resident, Department of Orthopaedics, Government Medical College, Kozhikode.

ABSTRACT

BACKGROUND

Various treatment modalities are described for the treatment of displaced transverse fractures of patella. As patella is very important biomechanically, open reduction and internal fixation with maximal preservation of patella is the standard treatment. Most commonly used method is modified tension band wiring with Kirschner wires. In a modification, cannulated screws are used instead of K wires and wire is passed through the cannulation of the screw and anterior surface of the patella.

The aim of our study was to compare the complications and functional outcomes after surgical treatment of patellar fractures using modified tension band wiring with Kirschner wires and with cannulated screws.

MATERIALS AND METHODS

This study was conducted in Department of Orthopaedics, Government Medical College, Kozhikode, during the period 2014-2015. Total sample size was 36. They were randomised into two groups. Among them, 17 had undergone tension band wiring with cannulated screws and 19 with Kirschner wires. They were evaluated in postoperative period at 1 month, 3 months and 6 months by looking for complications like postoperative infection, postoperative loss of reduction, skin irritation by prominent hardware. Functional outcome was assessed by knee pain score and Good Fellows grading of range of motion.

RESULTS

According to this study while comparing these two surgical techniques, there are no statistically significant differences in terms of complications and functional outcome. We observed that cannulated screw with tension band wiring has better patient tolerance, less complications like skin irritation by prominent hardware, loss of fixation and knee pain. We found that tension band wiring through cannulated screws is technically more difficult than using Kirschner wires.

CONCLUSION

Although, the statistical analysis showed no significant differences regarding the union and final outcome, cannulated screw with tension band wiring has better patient tolerance, less complications like prominent hardware, loss of fixation and knee pain. So, tension band wiring through cannulated screws for displaced transverse fractures is safe and effective alternative treatment with fewer complications and better functional outcome.

KEYWORDS

Tension Band Wiring, Kirschner Wires, Cannulated Screws, Good Fellows Grading.

HOW TO CITE THIS ARTICLE: Kumaran C, Muhammed Rafi M. Comparative study between tension band wiring of patellar fractures with Kirschner wires and cannulated screws in terms of functional outcome and complications. J. Evid. Based Med. Healthc. 2016; 3(92), 5039-5044. DOI: 10.18410/jebmh/2016/1057

BACKGROUND

Fractures of the patella constitute almost 1% of all skeletal traumas.[1] Various treatment modalities are described for the treatment of patellar fractures. The preferred method for fixation of transverse fracture is modified tension band construct, which convert anterior tension forces into compression forces at the articular surface.[2] This technique can substantially improve results because of its reliable fixation and allowance of early joint motion. However, this technique still has some shortcomings. First, the tension band is supplemented by longitudinal smooth Kirschner wires (K-wires) that bear the risk of loosening and migration. Second, direct inter fracture compression cannot be achieved with the K-wire and additionally there is potential of skin irritation. In a modification, cannulated screws are used instead of K-wires and wire is passed through the cannulation of the screw and anterior surface of the patella.[3] Biomechanical studies have shown that both resist fracture displacement, but cannulated screw construct have better stability.[4] The aim of this study is to compare modified tension band wiring using K wires and cannulated screws in terms of functional outcome and complications.

Financial or Other, Competing Interest: None.
Submission 27-09-2016, Peer Review 02-11-2016,
Acceptance 18-10-2016, Published 15-11-2016.
Corresponding Author:
Dr. Muhammed Rafi M,
Moozhikkal House, Vengad,
Kulathoor, Malappuram, Kerala-679338.
E-mail: dr.rafi49@gmail.com
DOI: 10.18410/jebmh/2016/1057

MATERIALS AND METHODS

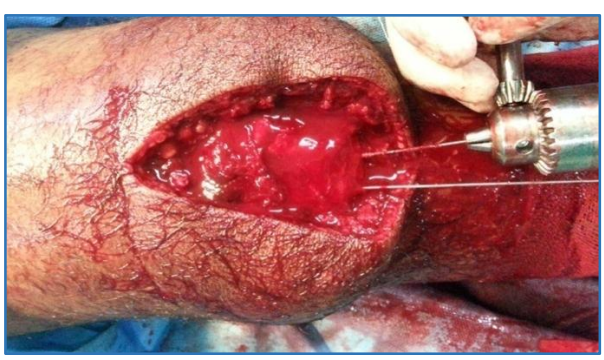
This prospective study, which was conducted in Department of Orthopaedics, Government Medical College, Kozhikode, included 36 patients (26 men, 10 women) aged 16 to 65 years operated on between February 2014 and June 2015. All cases had sustained displaced closed or type 1 open transverse patellar fracture. Approval of the Institutional Research Committee and Ethics Committee were obtained before the study has begun. Operations were considered when the articular displacement was greater than 2 mm or fragment separation was greater than 3 mm on radiography. The inclusion criteria were (1) AO/OTA 34-C1[5] fractures, i.e., patellar fractures primarily with a transverse fracture line and (2) AO/OTA 34-C2 fractures, i.e. transverse fractures with a single additional fragment created by a longitudinal fracture line. The exclusion criteria were AO/OTA 34-C3 fractures, i.e., comminuted fractures. Patients were divided into either a cable-cannulated screw tension band group or a modified K-wire tension band group according to their operation. There were 17 patients in the cable-cannulated screw tension band group (13 men, 4 women) with a mean age of 42.94 years (range, 24-65 years) and there were 19 patients in the K-wire tension band group (13 men, 6 women) with a mean age of 39.95 years (range, 19-65 years). Univariate t tests indicated there were no differences in age, gender, injury type, diabetic status between these two groups.

To produce uniformity in the study, a general guideline was made from the time of sending patients to the surgical procedure. Before sending a patient for the surgery, history was taken in detail, all preliminary general, local and radiographic evaluations were done. Each patient was counseled to follow strictly the postoperative rehabilitation protocol. Patients were prepared in a conventional way in the operation theatre.

Longitudinal or transverse midline incision over the mid portion of the patella was preferred. Fracture fragments were reduced anatomically by using large towel clips, patellar clamps or appropriate bone holding forceps, two 2 mm Kirschner wires or 4 mm cannulated screws from inferior to superior borders about 5 mm deep to the anterior surface of the patella along the lines dividing the patella into medial, central and lateral thirds. Then, a 20-gauge wire was passed in figure-of-eight fashion around the K wires or through the 4 mm cannulated screws and twisted on both sides. Proper reduction of the patella was checked by palpating the under surface of the patella with the knee extended. Retinacular tears were repaired with multiple interrupted sutures by Vicryl No. 1, skin was closed by skin staplers and immobilised with cylinder slab.

Anterior Midline Approach

Confirmation of the Articular Congruity



Insertion of Guidewires and Cannulated Drill Bit

Final Twisting of Steel Wire

Fluoroscopic Image

Posterior cylinder slab was given till suture removal on day 10 and passive and active ROM exercises started. Partial weight bearing advised at one month and full weight bearing at 2 months. Fracture with insecure fixation elderly and those with expected noncompliance were given cylinder cast for 3 weeks.

Postoperative evaluation was done based on clinical findings and radiographic evidence at 1, 3 and 6 months by looking for complications like loss of reduction, fixation failure, postoperative infection and skin irritation along with functional assessment by using knee pain score and Good Fellows grading of ROM.

Postoperative displacement or loss of reduction was defined as a fracture site displacement of greater than 2 mm as compared to the position on the immediate postoperative imaging tests. We defined a mild infection as a superficial infection that did not involve the bone, joint or implants and that was successfully treated on an outpatient basis with the use of oral antibiotics. The implant or the hardware was termed as 'painful hardware' when the skin was irritated by prominent hardware or migration of the K wires was seen.

KNEE PAIN SCORE

None	50
Mild/occasional	45
Stairs only	40
Walking & stairs	30
Moderate occasional	20
Continual	10
Severe	0

GOOD FELLOWS GRADING OF RANGE OF MOTION

Grading	Range of Motion
Excellent	Painless full movement and able to squat
Good	Full flexion and extension, but painful squat
Fair	Painless movement with 10-20 degrees limitation of flexion
Satisfactory	Painless movement with limitation of 20-40 degrees of flexion
Poor	Limitation of >40 degrees flexion

Statistical analysis was done by using SPSS software for windows for all analysis. The P value was set at a significance level of 0.05.

RESULTS

Patients were divided into two groups according to the type fixation, i.e. cannulated screw patients into Group 1 and K wire patients into Group 2. The mean age was 42.94 years in cannulated screw group and 39.95 in K-wire group. There is no significant difference between the groups (p=0.590).

There was a male predominance in both groups, but no statistically significant difference between two groups (p value = 0.433).

Percentage of diabetic patients were more in cannulated screw group, but there was no statistically significant change between these two groups.

KNEE PAIN SCORE

In the cannulated screw group, better knee pain score than K wire group, but there is no statistically significant difference between these two groups.

	Group	Frequency	Percent
1	Moderate	4	23.5
	Mild	13	76.5
	Total	**17**	**100.0**
2	Moderate	7	36.8
	Mild	12	63.2
	Total	**19**	**100.0**

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.749[a]	1	0.387

GOOD FELLOWS GRADE OF RANGE OF MOVEMENT

	Group	Frequency	Percent
1	Excellent	4	23.5
	Fair	6	35.3
	Good	6	35.3
	Satisfactory	1	5.9
	Total	**17**	**100.0**
2	Excellent	1	5.3
	Fair	8	42.1
	Good	7	36.8
	Satisfactory	3	15.8
	Total	**19**	**100.0**

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.061[a]	3	0.382

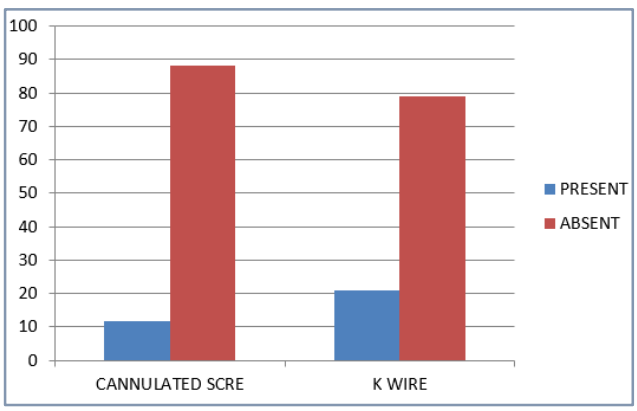
While analysing Good Fellows grading, more patient in the cannulated screw group have fair/excellent outcome than in the K wire group, but there is no statistically

significant difference between these two groups. None of the patient in both groups had poor grade.

INFECTION

	Group	Frequency	Percent
1	Absent	15	88.2
	Present	2	11.8
	Total	**17**	**100.0**
2	Absent	15	78.9
	Present	4	21.1
	Total	**19**	**100.0**

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.557[a]	1	0.455

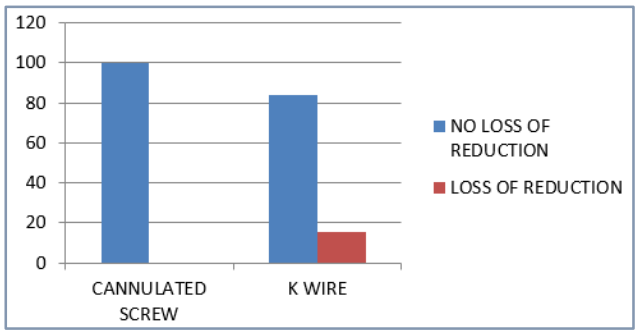


High incidence of infection is seen in K wire group than the cannulated screw group, but no statistically significant.

LOSS OF REDUCTION

	Group	Frequency	Percent
1	Absent	17	100.0
	Present	0	0
	Total	**17**	**100.0**
2	Absent	16	84.2
	Present	3	15.8
	Total	**19**	**100.0**

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.928[a]	1	0.087

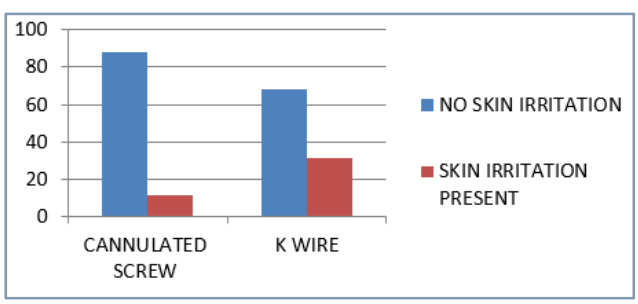


There was no postoperative loss of reduction in case of cannulated screw, but 15.8% had loss of reduction in K wire group, but this also is not significant statistically. None of them required re-surgery, all are managed by bracing alone.

SKIN IRRITATION

	Group	Frequency	Percent
1	Absent	15	88.2
	Present	2	11.8
	Total	**17**	**100.0**
2	Absent	13	68.4
	Present	6	31.6
	Total	**19**	**100.0**

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.038[a]	1	0.153



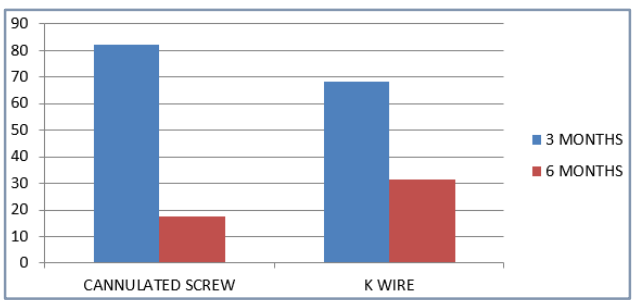
There was a high incidence of skin irritation in K wire group than cannulated screw group. But, no statistically significant change observed.

Skin Irritation with Mild Infection

HEALING TIME

	Group	Frequency	Percent
1	3 Months	14	82.3
	6 Months	3	17.7
	Total	**17**	**100.0**
2	3 Months	13	68.4
	6 Months	6	31.6
	Total	**19**	**100.0**

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.929[a]	1	0.335



82.3% of the cannulated screw group had fracture union at 3 months compared to 68.4% in the K wire group. But, as we did not assess fracture healing in between 3 to 6 months mean fracture healing time cannot be calculated.

Completely Healed Fracture at 3 Months

DISCUSSION

There are various methods described for the surgical treatment of transverse fractures of the patella and selecting an appropriate method for treating patellar fractures is a tough challenge for orthopaedists. The modified tension band wiring, which converts the tension forces acting anteriorly by the extensor mechanism into compressive force at the articular surface has long been the main stay of fixation. But, it has several short comings. So, we therefore compared the modified tension band wiring with K wires and with using cannulated screws in terms of functional outcome and complications.

There are several limitations for this study. First of all, the decision to treat patients with tension band wiring using K wires or cannulated screws was subject to selection bias as this was not a randomised study. Second, the degree to which the steel wire was tightened was not standardised, as it may influence the outcome. Another limitation is that the surgeries are performed by various surgeons in the Department of Medical College, Kozhikode, with various levels of experience and training. Finally, the numbers of patients enrolled in both groups are small and we followed the cases up to 6 months only, so that the late complications cannot be assessed.

Postoperative loss of reduction is considered the main complication of the modified K-wire band fixation of patella fracture.[6] In our study, K wire group had 3 cases of postoperative loss of reduction. But, none of cannulated screw patients had this complication. In overall, loss of fixation has been reported to occur in 0% to 20% of operatively treated patellar fractures.[7] A previous study[8] suggested the reason for poor outcomes of a K-wire tension band was initial separation of the fracture fragments caused by properties of the wire and further separation resulting from the change in wire plasticity. The method of bending the K wires also influence the outcome. We bent the proximal ends of the K wires only. Some authors argue that bending the distal end of the K wires will reduce the incidence of proximal migration of the K wires and loss of reduction.[9] Technique of twisting the steel wires also influence the rate of loosening.[9] We twisted the wire at two sites. The probability of cannulated screw tension band loosening and loss of reduction is very low owing to the dense cancellous bone of the patella and the fact that the distal end of the cannulated screw is threaded. In addition, the stainless steel cable tightly attaches to the patellar surface to limit the separation of fracture fragments as a tension band. In two separate studies, also the loosening is less in cannulated screw group.[10] Implant loosening may lead to loss of fixation and necessitates revision surgery, but none of our cases showed loss of reduction, which needs revision surgery. All our cases were healed with the protection of brace.

Postoperative Infection

Two patients in the cannulated screw group had a postoperative infection as compared with fourteen patients in the Kirschner wire group. All these are mild infection only. We defined a mild infection as a superficial infection that did not involve the bone, joint or implants and that were treated as an outpatient basis with use of oral antibiotics. Infections that required inpatient admission for intravenous antibiotics involved the bone, joint and/or implants or required a surgical irrigation and debridement were considered as severe infections. In prior studies, the incidence of postoperative infection after fixation of patellar fractures ranged from 3% to 10%.[11] It is possible that prominence of Kirschner wires causes more soft tissue irritation and wound-healing problems, which may increase the risk of postoperative infection.

Skin Irritation

Symptomatic implant irritation is the most commonly reported complication following fixation of a patellar fracture. In our study, 31.6% cases in the K wire group had symptomatic hardware, but only 11.8% of cannulated screw had the same problem. In some studies, symptoms attributable to wire irritation necessitated removal in approximately 15% of the cases.[11] K wire prominence and migration are the primary causes of skin irritation associated with this technique.[12] The tail of the cannulated screw buried at the superior or inferior pole of the patella and the screw threads are not exposed to the patellar surface; also, the steel wire tightly attaches to the patellar surface after being tightened reducing the risk of skin irritation and postoperative activity discomfort. The rate of the implant irritation that leads to implant removal could not be studied because of short period of follow up.

Healing Time

In our study, more patients in the cannulated screw had union at 3 months. But, accurate time required for healing could not be calculated as the follow up was done at 1, 3 and 6 months only.

Knee Pain Score

In cannulated screw group, 76.5% patient had mild only as comparing with K wire group, which had 63.2% of patients with score of mild. All remaining patients had a score of moderate. None of the patients in both these groups had score of severe.

Good Fellows grading of ROM- while considering Good Fellows grading of ROM 58.8% of patients in the cannulated screw group had excellent or fair grade at 6 months, but only 47.4% of patients in the K wire group had excellent or fair grade at 6 months.

In another study, comparing the functional outcome between these two constructs also showed better functional outcome in cannulated screw group. It may be due to less skin irritation and reduced incidence of loss of reduction in the cannulated screw group.[13]

CONCLUSION

Although, the statistical analysis showed no significant differences regarding the union and final outcome, cannulated screw with tension band wiring has better patient tolerance, less complications like prominent hardware, loss of fixation and knee pain. So, tension band wiring through cannulated screws for displaced transverse fractures is safe and effective alternative treatment with fewer complications and better functional outcome.

ACKNOWLEDGEMENT

We thank Dr. Nirmal for assistance in the statistical analysis of our data and preparation of figures and tables for this article. We also acknowledge the considerable support from fellow residents in the Department of Orthopaedics, Government Medical College, Kozhikode.

REFERENCES

1. Aboulafia AJ, Prickett B, Giltman L. Displaced pathological patella fracture due to gout. Orthopedics 1999;22(5):543-545.
2. Carpenter JE, Kasman R, Matthews LS. Fractures of the patella. J Bone Joint Surg Am 1993;75(10):1550-1561.
3. Muller ME, Allgower M, Schneider R, et al. Manual of internal fixation: techniques recommended by the AO-ASIF group. 3rd edn. Berlin, New York: Springer-Verlag 1990:248-253.
4. Berg EE. Open reduction internal fixation of displaced transverse patella fractures with figure-eight wiring through parallel cannulated compression screws. J Orthop Trauma 1997;11(8):573-576.
5. Carpenter JE, Kasman RA, Patel N, et al. Biomechanical evaluation of current patella fracture fixation techniques. J Orthop Trauma 1997;11(5):351-356.
6. Böstman O, Kiviluoto O, Santavirta S, et al. Fractures of the patella treated by operation. Arch Orthop Trauma Surg 1983;102(2):78-81.
7. John J, Wagner WW, Kuiper JH. Tension-band wiring of transverse fractures of patella. The effect of site of wire twists and orientation of stainless steel wire loop: a biomechanical investigation. Int Orthop 2007;31(5):703-707.
8. Fortis AP, Milis Z, Kostopoulos V, et al Experimental investigation of the tension band in fractures of the patella. Injury 2002;33(6):489-493.
9. Benjamin J, Bried J, Dohm M, et al. Biomechanical evaluation of various forms of fixation of transverse patellar fractures. J Orthop Trauma 1987;1(3):219-222.
10. Merchant TC, Dietz FR. Long-term follow-up after fractures of the tibial and fibular shafts. J Bone Joint Surg Am 1989;71(4):599-606.
11. Tian y, Zhou F, Hongquan JI, et al. Cannulated screw and cable are superior to modified tension band in the treatment of transverse patella fractures. Clin Orthop Res 2011;469(12):3429-3435.
12. Luna-Pizarro D, Amato D, Arellano F, et al. Comparison of a technique using a new percutaneous osteosynthesis device with conventional open surgery for displaced patella fractures in a randomized controlled trial. J Orthop Trauma 2006;20(8):529-535.
13. Gosal HS, Singh P, Field RE. Clinical experience of patellar fracture fixation using metal wire or non-absorbable polyester- a study of 37 cases. Injury 2001;32(2):129-135.