

Screws vs. Solid Wires - The Better Method for Transverse Patellar Fracture Fixation - A Prospective Randomised Study

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ABSTRACT

BACKGROUND

Patella is a sesamoid bone that plays an important role in the extensor apparatus of the knee joint. Fractures of the patella constitute about 1 % of all fractures. Definitive treatment of the patellar fractures depends on the type of fracture, displacement, joint congruity, and intactness of the extensor apparatus. There is significant controversy about the surgical options for displaced patellar fractures. Although conventionally tension band wiring using K-wires (TBW-K wire) is a common procedure, tension band wiring using cancellous screws (TBW-CCS) is gaining popularity. A study was undertaken to compare outcomes between the two procedures (TBW-CCS & TBW-K wire).

METHODS

A prospective randomised study was planned. Inclusion & exclusion criteria were laid down. Institutional ethical committee clearance was obtained. 68 consenting patients with transverse patellar fractures underwent surgery (TBW-CCS or TBW-K wire) after randomisation. Demographic, clinical, and radiological assessment was done. Bostman score was used as an outcome measure. Statistical analysis was done.

RESULTS

85.5 % of cancellous screw group patients had excellent outcome scores as against 41.2 % in the K wire group. The difference was statistically significant. 5.8 % of patients in the cancellous group complained of implant prominence as against 17.6 % in the K wire group which was statistically significant as well. Patients in TBW-CCS had a statistically significant difference in Bostman scores at 6 weeks, 3 months, and 6 months.

CONCLUSIONS

Tension band wiring with cannulated cancellous screws is a safe and reliable technique in the management of transverse patellar fractures with fewer chances of implant failure and soft tissue irritation. Based on our study, tension band wiring with cannulated cancellous screws is a better method to treat transverse fractures of the patella when compared to the modified tension band wiring technique using K-wire.

KEYWORDS

Patella, Transverse Fracture, Tension Band Wiring, Cancellous Screws

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BACKGROUND

Patella is a sesamoid bone that plays an important role in the extensor apparatus of the knee joint. Fractures of the Patella are commonly seen in the age group of 20 - 50 years and they constitute about 1 % of all fractures.¹ To preserve optimal function, adequate surgical stabilization and post-operative rehabilitation are essential. Among the various types of Patellar fractures, displaced transverse fractures are common.^{1,2} Definitive treatment of the Patellar fracture depends on the type of fracture, displacement, joint congruity, and intactness of the extensor apparatus.³

Undisplaced or minimally displaced fractures that maintain joint congruity with intact extensor apparatus can be managed conservatively with a cylindrical cast. A displaced fracture (displacement of more than 2 – 3 mm) with a torn extensor apparatus needs surgical stabilization for the restoration of extensor apparatus and joint congruity thereby promoting early mobilization.^{2,3,4,5} Anatomical reduction is of paramount importance in maintaining joint congruity as well as in the recovery of quadriceps function. There are numerous methods for surgical stabilization namely open reduction and internal fixation with cerclage wiring, modified tension band wiring, partial patellectomy, and total patellectomy. Surgical options have evolved and improved with time starting from simple cerclage wiring to tension band wiring.

Conventionally, these fractures are fixed using modified tension band wiring (TBW with K-wires).⁶ Tension band principal works by converting tensile forces into compression forces. The K wires at times may become prominent early during mobilization and may make activities like kneeling more difficult. As an alternative, cannulated cancellous screws (CCS) have also been used.^{7,8,9}

There is a theoretical advantage with cancellous screws as they act like lag screws compressing fracture site. The addition of SS wire with cannulated cancellous screw makes it biomechanically more stable and stronger than tension band wiring with K wires.⁵

There is significant controversy about the two surgical options (CCS vs. K-wire) for displaced patellar fractures. The modified tension band (TBW K-wire) technique for the treatment of patellar fractures was first proposed in 1950 and has been subsequently recommended as the primary treatment method for patellar fractures.^{10,11,12} Implant prominence and irritation were twice more common in tension band wiring with K wires. Studies have shown that patients operated with modified TBW, had complaints postoperatively of implant loosening and prominence,¹³ irritation underneath the skin, difficulty in performing daily routine activities such as squatting and kneeling.⁴ Percutaneous screw insertion techniques have also been described for minimally displaced patella fractures.¹⁴

A study was hence undertaken to compare outcomes following the two procedures (A) Tension band wiring with cannulated cancellous screws (TBW-CCS) and (B) Tension band wiring with K wires (TBW-K).

Objectives

- To assess the clinical outcome, radiological union and post-operative complications of displaced transverse patellar fractures treated with tension band wiring with cannulated cancellous screws (TBW-CCS group).
- To assess the clinical outcome, radiological union and post-operative complications of displaced transverse patellar fractures treated with modified tension band wiring with K wires (TBW-K group).
- To compare the two surgical groups (TBW-CCS group & TBW-K group) and to assess if one surgical technique is better than other with respect to parameters clinical outcome, radiological union and postoperative complications.

METHODS

A prospective, hospital-based interventional study was conducted. Institutional ethical committee clearance was obtained (IHEC No: PESIMSR / IHEC / 87 / 2017 - 18). Inclusion and exclusion criteria were laid. Inclusion criteria included all patients presenting with isolated transverse Patellar fractures from Jan 2018 to Dec 2019. Displaced fracture of the patella was defined as a fracture with any or all of the findings like (a) more than 3 mm vertical displacement, (b) more than 2 mm articular step off (joint incongruity), and (c) torn extensor apparatus (absent active straight leg raise test). Displaced comminuted patellar fractures and inferior or superior pole avulsion fractures which needed different surgical technique were excluded from the study. Open fractures (Gustilo Anderson type 3B and 3C needing additional soft tissue procedures; adversely affecting outcome) and patients who were not willing to be a part of the study were also excluded from the study. The consenting study subjects were randomly allocated into two groups (TBW-CCS & TBW-K group) using the sealed envelope technique with computer-generated randomization codes. TBW-CCS group included patients who underwent tension band wiring with cannulated cancellous screws and the TBW-K group underwent tension band wiring with K wires.

Radiographic Assessment

Standard antero-posterior and lateral radiographs were taken routinely for all the patients preoperatively, immediate post postoperative period, and as well as at the follow-up visits to assess the fracture reduction and healing.

Surgical Procedure

After standard pre-anaesthetic evaluation and physician consultation, patients underwent surgeries at the earliest under spinal anaesthesia and tourniquet control. A midline vertical skin incision was used. In the TBW-CCS group, after fracture reduction, two parallel cannulated screws were inserted with 18-gauge stainless steel (SS) wire passed through the cannulations in the screws and crossed

over the anterior surface of the patella¹³ (butterfly pattern) and knot buried in the superolateral pole of the Patella (Figure 1A & 1B). In the TBW-K group, K wires of appropriate size were drilled through the Patella and an SS wire passed around the wires in the figure of "8" configuration (Figure 2A & 2B). Fracture reduction and fixation were confirmed clinically and radiologically using C-arm guidance. Joint lavage was done, and clots were evacuated. The surgical wound was closed in layers and the bulky dressing was applied. Knee was immobilized using cylindrical plaster of Paris slab with the knee in extension.

Post-Operative Details

Both groups of patients received standard postoperative care and antibiotics. Regular dressings were done, and suture removal was done at 10 - 12 days. Patients were made to bear weight as per their pain tolerance using walking aids. Supervised joint range of motion of exercises and physiotherapy were begun in the first week.

Follow Up Evaluation

Following discharge from the hospital, patients were followed-up at regular monthly intervals. Clinical and radiological assessment for the outcome of fracture union and knee function was done during visits. The Bostman Knee score assessment¹⁵ was done at 6 weeks, 3rd month, and 6th postoperative month. Any complications that developed were also documented, evaluated, and simultaneously managed.

Statistical Analysis

The data was entered into MS Excel 2007 version and analysed using SPSS software. The categorical variables were analysed by using percentages, and the Fisher's exact test was used for comparison. The continuous variables were analysed by calculating the mean $\pm$ standard deviation. Shapiro-Wilk test was used to test whether the data conform to the normal distribution. The t-test was planned for normal distribution and the Mann-Whitney U test was used for non-normal distribution of data between the two groups. A P-value < 0.05 was considered as statistically significant.

RESULTS

A total of 70 study subjects fulfilling inclusion-exclusion criteria were enrolled in this study. Out of whom 2 patients were lost to follow-up. The age of the participants ranged from 18 to 65 years (average - 39.8 years). The average age in TBW-CCS was 39.3 yrs. whereas in the TBW-K group it was 40.5 yrs. There was male predominance in both the groups; 70.6 % in the TBW-CCS group and 67.6 % in the TBW-K group (Table 1).

Nearly two-thirds of the patients sustained the fracture due to road traffic accidents, which was comparable in

both groups. The right side was commonly involved in both the groups 64.7 % and 55.8 % respectively. 14.8 % and 20.6 % of patients presented later than one week in the TBW-CCS group and TBW-K group respectively. 5.9 % of the total patients (4 out of 68) presented with open Patellar fractures which could be managed with primary skin suturing without the need for flaps (Table 1).

Variable	TBW-CCS N (%)	TBW-K Wire N (%)
Average Age	39.23	40.50
Gender		
Male	24 (70.6)	23 (67.6)
Female	10 (29.4)	11 (32.4)
Side		
Right	22 (64.7)	19 (55.8)
Left	12 (35.3)	15 (44.2)
Mode of injury		
Road traffic accident	23 (67.6)	23 (67.6)
Slip and fall	11 (32.4)	11 (32.4)
Delay in presentation		
Within 1 week	29 (85.2)	27 (79.4)
More than 1 week	5 (14.8)	7 (20.6)
Type of fracture		
Closed	31 (91.1)	33 (97)
Open	3 (8.9)	1 (3)

Table 1. Demographic Data

Variable	TBW-CCS	TBW-K	Significance
Average Bostman score at 6 weeks*	15.1	13	0.0034*
Average Bostman score at 3 months*	22.1	19.8	0.0031*
Average Bostman score at 6 months*	29.4	26.4	0.002*

Table 2. Comparison of Average Bostman Scores between the Two Groups

*indicates statistically significant difference

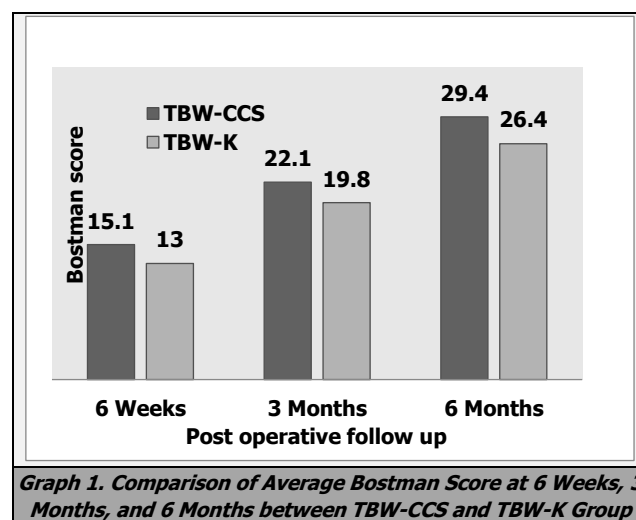
#Mann-Whitney test was used

Variables	TBW-CCS	TBW-K	P-Value
Union at 3 months			
Yes	34 (100 %)	29 (85.2 %)	
No	00 (0.0)	05 (14.8)	0.05
Pain			
Yes	2 (5.8 %)	8 (23.5 %)	
No	32 (94.2 %)	26 (76.5 %)	0.08
Implant prominence			
Yes	2 (5.8 %)	6 (17.6 %)	
No	32 (94.2 %)	28 (82.4 %)	0.26
Stiffness			
Yes	0 (0.0 %)	6 (17.6 %)	
No	34 (100.0 %)	28 (82.4 %)	0.02*
Infection			
Yes	0 (0.0 %)	1 (2.9 %)	
No	34 (100.0 %)	33 (97.1)	1.00

Table 3. Association of Outcome and Complications among the Two Groups*

*indicates statistically significant association

• Fisher's exact test applied



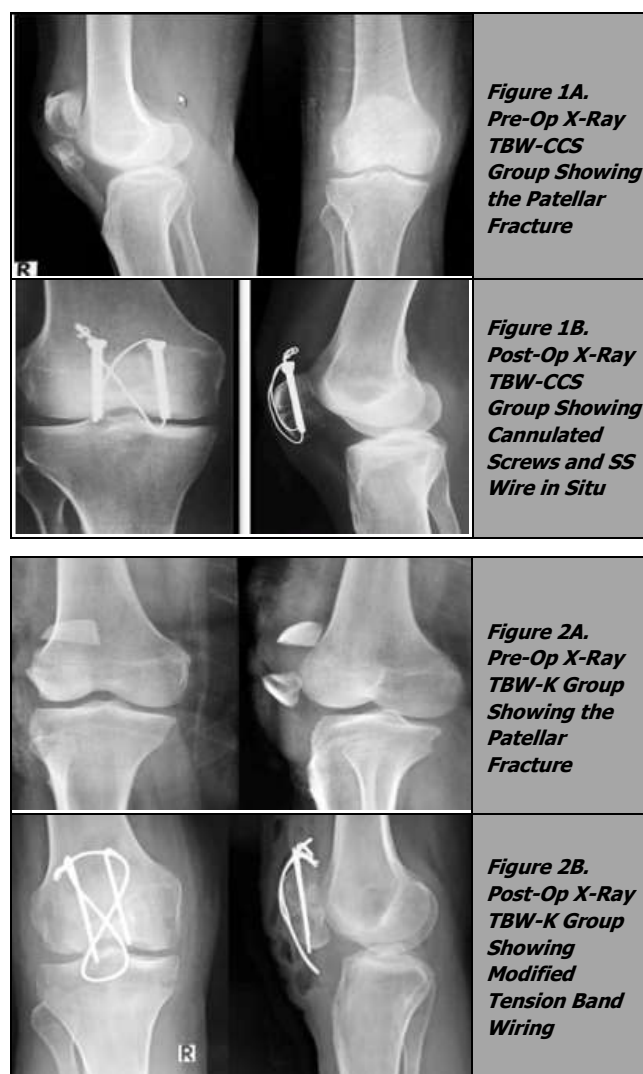
Graph 1. Comparison of Average Bostman Score at 6 Weeks, 3 Months, and 6 Months between TBW-CCS and TBW-K Group

Three patients had well-controlled type 2 diabetes mellitus (one patient in the TBW-CCS group and 2 in the TBW-K group). The presence of diabetes did not adversely affect the outcome. Outcomes were assessed in both groups using the BOSTMAN score (Table 2). A score of 28 -

30 was considered an excellent outcome, a score of 27 to 21 good, and a score of less than 20 a poor outcome. Mean Bostman scores were assessed which were 15.1, 22.1, and 29.4 in the TBW-CCS group at 6 weeks, 3 months, and 6 months. The scores in the TBW-K group were 13, 19.8, and 26.4 respectively in a similar time frame.

Bostman scores improved with time in both groups. The difference in outcome at 6 weeks, 3 months, and 6 months were highly significant (P-Value = 0.0034 at 6 weeks, 0.0031 at 3 months, and 0.002 at 6 months respectively); better scores being observed in the TBW-CCS group. Overall, excellent scores were achieved by 85.3 % of patients in the TBW-CCS group as compared to 41.2 % of patients in the TBW-K group.

The clinical and radiological union was earlier in the TBW-CCS group (Table 3). 100 % and 85.2 % patellar fractures went onto union by 12 weeks from TBW-CCS and TBW-K group respectively. The difference was statistically significant (P = 0.05)



Complications

In the TBW-K wire group, 23.5 % (8 of 34 patients) had postoperative complications such as implant prominence, knee stiffness, and infection (Table 3). Seven of those patients were managed conservatively and one patient who

also had delayed surgical site infection which was treated by implant removal and intravenous antibiotics. 5.8 % (2 of 34 patients) had implant prominence and pain in TBW-CCS group which was managed conservatively. There was a statistically significant difference in the patients who had joint stiffness between the two groups (P-value 0.02). The differences in pain, implant prominence, and infection rates were not statistically significant P-value 0.08, 0.26, and 1.00 respectively (Table 3).

DISCUSSION

Conventionally, displaced transverse patellar fractures are fixed using modified tension band wiring with K wires and figure of eight stainless steel wire, which converts tensile forces into compression forces. However, the use of K wire fixation resulted in implant loosening, prominence, and irritation beneath the skin.^{2,3,4} Some of the studies have reported that cancellous screws provide better fixation and can avoid complications like irritation, implant prominence, and loosening.^{2,3,4,5,8} Some studies have also shown that modified tension band fixation (TBW with K-wire) is better and traditionally being practiced because of the simplicity of the technique.^{6,7}

The majority of the participants in this study were men. This trend was seen in both groups (Table 1). This distribution is similar to previous studies where men go out more often compared to women for occupational activities and they are prone to trauma and injuries.^{2,3,5,7}

The mean age of the patients in our study was 39.8 years, which was similar to the age incidence in other studies.^{2,3,5,7} In this study, road traffic accidents (RTA) was the common cause of the patellar fracture. In other studies, findings such as slip and fall were common compared to RTA.^{5,6,8} Poor road conditions and widely prevalent two-wheeler transportation could have resulted in RTA as a common occurrence. Nearly eighteen percent of the patients presented later than a week for treatment. Delay has been due to widespread "traditional bone setters" osteopaths prevalent in this geographic area. Although patients presenting early had better outcomes the difference was not statistically significant.

TBW-CCS group reported better outcome scores compared to the TBW-K group at 6 weeks, 3 months and also at 6 months postoperatively. Bostman scores assessment at six months postoperatively excellent scores were reported in 85.3 % in the TBW-CCS group, whereas in the TBW-K group it was 41.2 %. The observation in this study was comparable to Khan et al.⁵ The improvements in outcome in tension band wiring with cannulated cancellous screws were statistically significant.

Smith et al.¹⁶ in a retrospective study observed that early loss of reduction, implant prominence as common complication with modified tension band wiring with K wire. Hung et al.¹⁷ Observed 10 % of patients with tension band wiring – Kwire needed surgery for prominent implant. In our study as well, there was an increased association of implant prominence and pain with TBW-K group.

The radiological union in the TBW-CCS group was also earlier. 100 % union was achieved by 12 weeks compared to 85.2 % in the TBW-K group. This difference in the radiological union was statistically significant ($P = 0.05$). In the study by Shrestha et al.⁶ patellar fracture union rate was 8 - 16 weeks, but there was no statistically significant difference between the groups. Different studies by Berg et al.¹⁸ Khan et al.⁵ reported 13 weeks and 10.7 weeks of average fracture union time respectively. Studies by Tan et al.¹⁹ and Yun tian et al.⁷ have reported 10 weeks and 8 weeks of average fracture union time in both groups. In a meta-analysis by Y Zhang et al.²⁰ there was no difference in the union and infection rates; but the results were superior in the TBW-CCS group as far as incidence of complications mainly implant prominence was concerned. In the recent study, Chengwu Liu et al.²¹ found significantly lower infection rates in the cancellous screw group, and significantly better improvement in pain, Bostman scores in the cancellous screw group.

Totally eight patients (2 in TBW-CCS group and 6 in TBW-K group) complained of implant prominence as it hindered kneeling on the ground. In the TBW-K group, 23.5 % of patients presented with postoperative complications like implant prominence, infection, and knee stiffness. One patient presented with infection, implant loosening and prominence, necessitating implant removal & debridement. Infection rates in Patellar fracture surgical fixation range from 3 - 10 %.^{10,11,12,13,16} This study also reported lower infection rates (1.5 %, $N = 1$).

Scope for Further Research

From our study, it is evident that tension band wiring with cannulated cancellous screws is a better option for transverse patellar fractures than modified tension band wiring with K wires. There is scope for further improvement in surgical techniques and implant devices. Minimally invasive techniques like arthroscopy assisted percutaneous cancellous screw application techniques can also be evaluated. The role of endobutton as an implant choice can also be studied in select transverse patellar fractures. There is also scope for pre-contoured locking tension band plates for absolute reduction.

CONCLUSIONS

Tension band wiring with cannulated cancellous screws is a safe & reliable technique in the management of transverse patellar fractures. There are fewer chances of implant failure & soft tissue irritation. The union also is earlier in cancellous screw technique than in the tension band with K wires. Based on our study TBW with cannulated cancellous screws is a better method to treat transverse fractures of the patella when compared to the modified tension band wiring technique.

Limitations

This was a single-center study with a small sample size. Hence projection of the results for a general population may not be accurate. A multicentre study with a larger sample and longer-term follow-up is needed for confirming the results obtained in the present study.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

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REFERENCES

- [1] Lotke PA, Ecker ML. Transverse fractures of the patella. *Clin Orthop Relat Res* 1981;(158):180-184.
- [2] 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.
- [3] Catalano JB, Iannaccone WM, Marczyk S, et al. Open fractures of the patella: long-term functional outcome. *J Trauma* 1995;39(3):439-444.
- [4] Hung LK, Chan KM, Chow YN, et al. Fractured patella: operative treatment using the tension band principle. *Injury* 1985;16(5):343-347.
- [5] Khan I, Dar MY, Rashid S, et al. Internal fixation of transverse patella fractures using cannulated cancellous screws with anterior tension band wiring. *Malaysian Orthopaedic Journal* 2016;10(2):21-26.
- [6] Shrestha P, Chalise PK, Paudel S, et al. Comparative study of modified tension band wiring versus tension band through parallel cannulated cancellous screws in patella fractures. *Open Ortho Res J* 2018.
- [7] Tian Y, Zhou F, Ji H, et al. Cannulated screw and cable are superior to modified tension band in the treatment of transverse patella fractures. *Clin Orthop Relat Res* 2011;469(12):3429-3435. <https://doi.org/10.1007/s11999-011-1913-z>
- [8] 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.
- [9] Cho JH. Percutaneous cannulated screws with tension band wiring technique in patella fractures. *Knee Surg Relat Res* 2013;25(4):215-219.
- [10] Cramer KE, Moed BR. Patellar fractures: contemporary approach to treatment. *J Am Acad Orthop Surg* 1997;5(6):323-331.
- [11] 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.
- [12] Lefaivre KA, O'Brien PJ, Broekhuysen HM, et al. Modified tension band technique for patella fractures. *Orthopaedics & Traumatology: Surgery & Research* 2010;96:579-582.

- [13] Hatab S, Tanagho A. Lessons learned using screws and cable in patellar fractures. *International Journal of Orthopaedics Sciences* 2017;3(3):96-100.
- [14] Lin T, Liu J, Xiao B, et al. Comparison of the outcomes of cannulated screws vs. modified tension band wiring fixation techniques in the management of mildly displaced patellar fractures. *BMC Musculoskeletal Disord* 2015;16:282. <https://doi.org/10.1186/s12891-015-0719-7>
- [15] Böstman O, Kiviluoto O, Nirhamo J. Comminuted displaced fractures of the patella. *Injury* 1981;13(3):196-202.
- [16] Smith ST, Cramer KE, Karges DE, et al. Early complications in the operative treatment of patella fractures. *J Orthop Trauma* 1997;11(3):183-187.
- [17] Hung LK, Chan KM, Chow YN, et al. Fractured patella: operative treatment using the tension band principle. *Injury* 1985;16(5):343-347.
- [18] 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.
- [19] Tan H, Dai P, Yuan Y. Clinical results of treatment using a modified K-wire tension band versus a cannulated screw tension band in transverse patella fractures: a strobe-compliant retrospective observational study. *Med USA* 2016;95(40):e4992.
- [20] Zhang Y, Xu Z, Zhong W, et al. Efficacy of Kwire tension band fixation compared with other alternatives for patella fractures: a meta-analysis. *Journal of Orthopaedic Surgery and Research* 2018;13(1):226.
- [21] Liu C, Ren H, Wan C, et al. Comparison of the therapeutic effects of tension band with cannulated screw and tension band with Kirschner wire on patella fracture. *Comput Math Methods Med* 2020;2020:4065978.