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Original Article

Titanium cannulated lag screw versus titanium cable-cannulated lag screw tension band for treatment of transverse patellar fractures

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Abstract: Although the titanium cable-cannulated lag screw tension band (TCCLSTB) technique is an effective method for fixation of transverse patellar fractures, it has shortcomings, such as extensive soft tissue damage and complex manipulation. We conducted a retrospective comparison of the titanium cannulated lag screw (TCLS) and TCCLSTB technique. We retrospectively reviewed 74 patients with transverse patellar fractures (38 in the TCLS group and 36 in the TCCLSTB group). Follow-up was at least 1 year (range, 1-3 years). Comparison criteria were operation time, operative incision, fracture reduction, fracture healing time, the Iowa score for knee function, and complications. The TCLS group showed shorter operation time, lesser operative incision and equal fracture reduction, fracture healing time, and knee function compared with the TCCLSTB group. There was no complication in the both groups. The TCLS technique without the cost of titanium cable tension band saved the operation time and had lesser operative incision. Therefore it should be considered as an alternative method for treatment of transverse patellar fractures.

Keywords: Transverse fractures of the patella, titanium cannulated lag screw, tension band, titanium cable

Introduction

Transverse fractures occupy approximately 50% of displaced patellar fractures [1-6]. The modified Kirschner wires (K-wires) tension band is commonly recommended as the primary treatment method to cure transverse patellar fractures [5, 7-10]. The advantage of tension band is able to convert the tension forces of bands into compression forces acting on the anterior surface [2, 10, 11]. This would achieve a reliable fixation and allow early joint motion. However, the longitudinal smooth K-wires the smooth K-wires have the risk of loosening, migration and skin irritation because the smooth K-wires have no threaded sectors to prevent shifting [2, 3, 11, 12]. In order to remedy the disadvantages of the modified K-wire tension band, Yun Tian MD et al introduced an improved technique, the titanium cable-cannulated lag screw tension band (TCCLSTB) construct to treat patellar fractures [2]. We have adopted another improved technique, the titanium cannulated lag screw (TCLS) technique without cable tension band, which are also able to overcome the shortcomings of the modified K-wire tension band in that the tatanium cannulated lag screws (SynthesInc, West Chester, PA, USA) can firmly fixed the transverse fractures of patella [13]. By now, there is no report about the comparative research between the two methods (TCLS technique versus TCCLSTB technique for treatment of transverse patellar fractures).

Here, we compared TCLS technique with TCCLSTB technique to determine which technique could (1) achieve better reduction; (2) shorten the operation time and the length of operative incision; (3) decrease complications, such as loosening of implants and skin irritations; and (4) achieve better knee function.

Patients and methods

The retrospective study contained 78 patients (45 men, 33 women) aged 20 to 79 years (mean,

Table 1. Differences between the two groups

Variable	TCLS (n=38)	TCCLSTB (n=36)	Chi square/ *t* value	*p* Value
Age (years)*	53.3 ± 25.7	52.3 ± 22.70	-0.297	0.732
Gender				
Male	22	20	1.89	0.107
Female	16	16		
Injury reason				
Slip and fall	34	33	0.285	0.593
Car accident	4	3		
AO/OTA classification				
34-C1	31	30	1.78	0.112
34-C2	7	6		
Inter fragmentary gap (mm)*	15.6 ± 8.9	14.9 ± 6.6	-0.456	0.532

*Value are expressed as mean ± SD; the remaining values are expressed as number of patients.

52.9 years) treated between April 2009 and June 2013 and the follow-up to them was at least 1 year (range, 1-3 years). This study was approved by the ethics review committee of Jilin University, and written informed consent was obtained from all patients. The majority of those injuries occur from a direct blow from fall accidents (67 patients) and car crash accidents (11 patients). The operation time for fracture was 1 to 7 days (mean, 3 days) after injuries. Four patients were lost to follow-up. Of the 74 patients, 38 were randomly assigned to the TCLS group (22 men and 16 women; mean age 53.3 years, range 20-79 years) and 36 were randomly assigned to the TCCLSTB group (20 men and 16 women; mean age 52.3 years, range 20-75 years). There were no differences in age, gender, mechanism of injury, fracture classification between the three groups under univariate t tests (**Table 1**).

The inclusion criteria were closed displaced transverse fracture of patella. A displaced fracture of the patella is defined by fracture fragment separation of more than 3 mm or an articular incongruity of 2 mm or more. AO/OTA 34-C1 fractures (patellar fractures primarily with a transverse fracture line) and AO/OTA 34-C2 fractures (transverse fractures with a single additional fragment created by a longitudinal fracture line) are enclosed [2]. AO/OTA 34-C3 fractures (comminuted fractures) are excluded [2].

All surgeries were performed by the authors 1, 7 and 8. All of the surgeons are experienced in skeletal trauma. General anesthesia was adopted for the surgery. The patient was positioned in the dorsal decubitus position, with a sterile soft cushion under the injured knee, which pose the joint in a 20° flexed position and free to perform flexion-extension movements. We use one lag screw fix the longitudinal fracture by inserting perpendicularly to the fracture line.

In TCLS group, a little transverse incision (about 4 cm) was made along the fracture line from the skin to the prepatellar fascia. After the fracture line was exposed, the prepatellar soft tissue and periosteum were put out of the fracture gap, the hematoma and traumatic bone debris were removed, and the articular cavity was washed with normal saline solution. Anatomic reduction of the articular surface was achieved and maintained by manipulative adjusting of the position of a reduction clamp on the fragments, which was confirmed by an intraoperative C-arm fluoroscopy. After the reduction of articular surface, two parallel guide pins (1.2-mm diameter) were drilled superiorly into the patella from the lower side of the apex with a 2-cm space and a 5- to 10-mm distance from the patellar articular surface (**Figure 1**).

After drilling along the K wire with a cannulated bit (2.5 mm) and measuring its depth, we screwed a 4.0-mm titanium cannulated lag screw (Synthes Inc, West Chester, PA, USA) along the K wire. We should not fix the first screw firmly and keep the K wire into the screw. After screwed the second cannulated lag screw into the patella, we alternately tightened the screws and removed the K wires (**Figure 1**).

In TCCLSTB group, an anterior longitudinal incision was selected. Two parallel cannulated lag screw guide pins (1.2-mm diameter) were temporarily used to fix the fractures after the reduction of articular surface was got as above. Two parallel wires were drilled through from the lower pole to the superior pole of the patella,

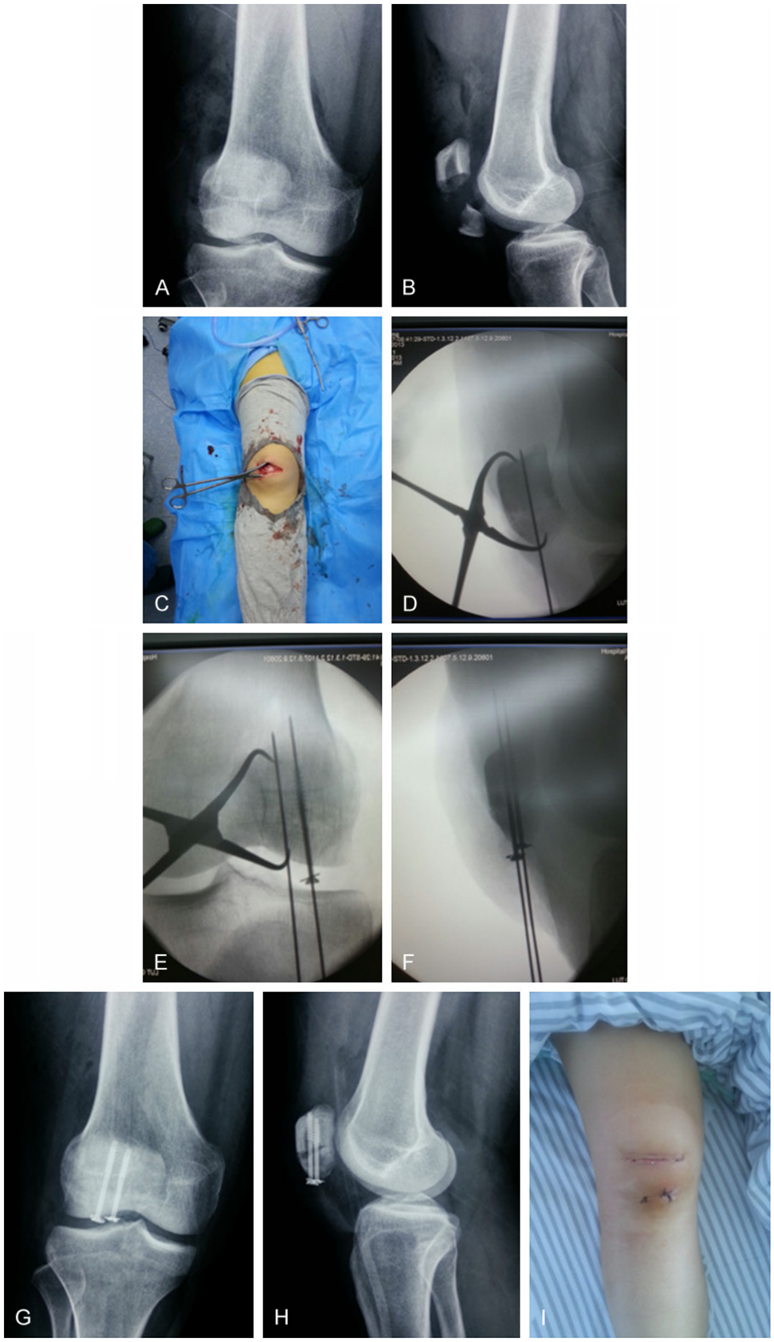

Figure 1. The titanium cannulated lag screw technique to fixing the transverse patella fracture is shown. The preoperative anteroposterior (A) and lateral (B) radiograph shows a displaced transverse patellar fracture of 24-year-old woman and the fracture line is near distal of the patella. (C, D) The patellar fracture line was exposed through the mini transverse incision along the fracture line and was temporally reduced by a bone holding forceps. (E, F) Two 1.2-mm-diameter K-wires are drilled from the lower pole to the superior pole of the patella after reducing the fracture and two 4.0-mm-diameter cannulated screws are screwed along the guide wire. (G) Postoperative anterposterior and (H) lateral radiographs show the anatomic reduction of the transverse patella fracture. (I) The postoperative incision is shown.

with a 2-cm space and a 5- to 10-mm distance from the articular surface (**Figure 2**). After drilling along the guide pin with a cannulated bit (2.5 mm) and measuring its depth, we screwed a 4.0-mm titanium cannulated lag screw (Synthes Inc, West Chester, PA, USA) along the guide wire. We then screwed in the second cannulated screw and alternately tightened the screws. We removed the guide wire and threaded a 1.3-mm-diameter titanium cable (consisting of a total of nine strands; Zimmer Inc, Warsaw, IN, USA) through each of the cannulated screws. We then tightened the titanium cable anterior to the patella to form the tension band, fixed the titanium cable with cable clamps, and cut off the excessive titanium cable.

A posterior splint from groin to ankle provided sufficient immobilization during the early 3 weeks. Quadriceps femoris contraction exercises were performed 1 day after the operation and within 4 days should be lifting the leg off the bed. At 14 days, the sutures were removed, and cylinder cast is applied with the knee in extension. The patient was allowed to be ambulatory, using crutches when active muscular control of the leg has been obtained. The immobilization was removed at 3 weeks, and gentle active and active-assisted exercises were begun. As muscle power returns, the crutches would be discarded at 6 to 8 weeks.

Patients were reexamined at 1, 2, 3, 6, and 12 months after the operation to observe the fracture healing. Fracture healing was defined as when a patient had no local pain or tenderness, the ability to walk well without help, and evidence

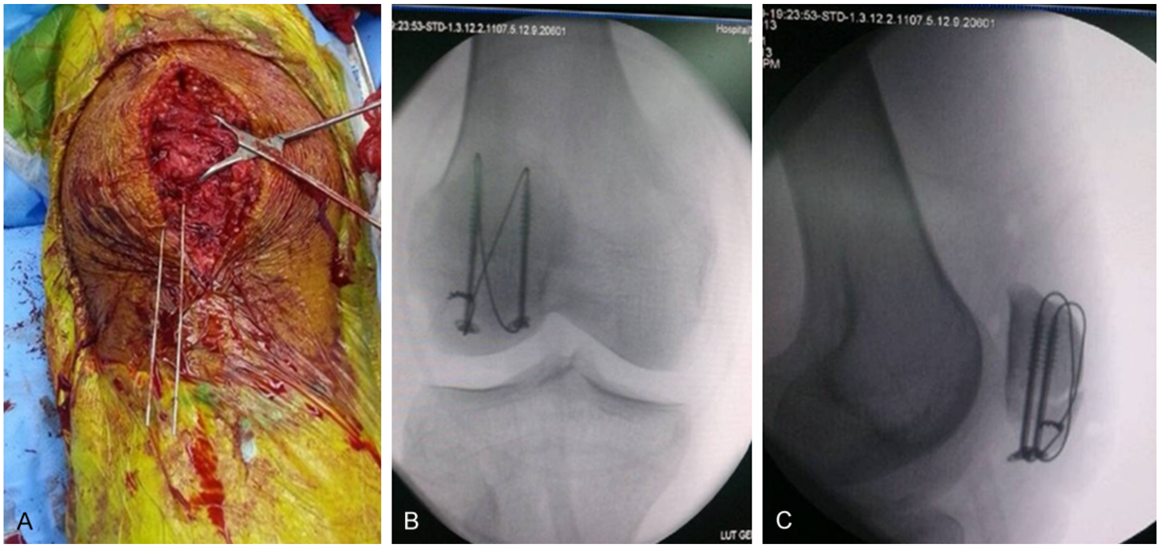

Figure 2. A transverse patella fracture of 46-year old man was fixed with titanium cable-cannulated lag screw tension band. (A) The patellar fracture line was exposed via an anterior longitudinal incision and was temporally reduced by a bone holding forceps. Two 1.2-mm-diameter K-wires are drilled from the lower pole to the superior pole of the patella after reducing the fracture and two 4.0-mm-diameter cannulated screws are screwed along the guide wire. Anterposterior (B) and lateral (C) radiograph shows that titanium cables are threaded through the cannulated screws and tightened anterior to the patella.

Table 2. Result of the two groups

Varibles	TCLS	TCCLSTB	Chi square/*t* value	*p* Value
Operation time (minutes)☆	45 ± 15	64 ± 22		< 0.001
Incision length (mm)☆	42.2 ± 12.3	75.5 ± 18.7		< 0.001
Postoperative interfragmentary gap				
< 1 mm	35	33	0.274	0.475
≥ 1 mm	3	3		
Knee function*				0.167
90-100	29	28		
80-89	9	8		
70-79	0	0		
≤ 69	0	0		
Fracture healing time (months)☆	2.93 ± 1.15	3.00 ± 1	0.321	0.642
Complications				0.543
0	38	36		
1	0	0		
2	0	0		

*Iowa knee score (total score = 100 points): 90-100 = excellent; 80-89 = good; 70-79 = fair; ≤ 69 = poor; ☆values are expressed as mean ± SD; the remaining value are expressed as number of patients.

of trabecular bone growing across the fracture line.

One year after surgery, the knee function was evaluated according to the Iowa knee score criteria, which evaluates knee function in daily life, inquires about joint pain when weight bearing, walking gait, the existence of deformity or instability, and joint ROM. The total score is 100 points: 90 to 100 points is excellent, 80 to 89 points is good, 70 to 79 points is fair, and less than 70 points is poor.

Results were analyzed by SPSS statistical software (SPSS Inc, Chicago, IL, USA). The differences in internal fixation fracture operation

Table 3. Results of logistic regression analysis*

Dependent Variable	Incision length		Operation time		Postoperative interfragmentary gap		Complications		Healing time		Knee function	
	Odds ratio	*p* Value	Odds ratio	*p* Value	Odds ratio	*p* Value	Odds ratio	*p* Value	Odds ratio	*p* Value	Odds ratio	*p* Value
Gender (male)	1.16	0.71	1.13	0.63	1.14	0.72	1.213	0.864	1.17	0. 96	0.18	0.72
Age (> 50 years)	0.36	0.13	0.45	0.21	0.84	0.15	1.03	0.131	1.11	0.85	0.88	0.31
Injury (fall and slip)	5.78	0.90	5. 18	0.12	5.63	0.14	3.568	0.168	0.00	0.99	5. 8	0.52
AO/OTA classification (34-C2)	0.54	0.32	0.83	0.82	0.632	0.45	1. 21	0.61	7.09	0.016	3.3	0.12
Operation method (TCLS)	4.37	0.0001	3.37	0.0001	3.68	0.18	1.3	0.86	1.62	0. 94	1.21	0.79

*Variables included: gender (male, female); age (≤ 50 years, > 50 years), Injury (fall and slip), AO/OTA classification (34-C1, 34-C2), operation method (TCLS and TCCLSTB), postoperative interfragmentary gap (≥ 1 mm, < 1 mm), complications (loosening of implant, failure of fixation, skin irritation), healing time (≥ 3 months, < 3 months), knee function (excellent, less than excellent). The logistic regression was considered significantly different when P < 0.05.

time, healing time, knee function, and incidence of complications between the two groups were analyzed using univariate analysis. Logistic regression was used to determine whether gender, age, injury mechanisms, and fracture classifications had an influence on differences of the postoperative interfragmentary gap, fracture healing time, complications, and knee function between the two groups. The logistic regression determining which of the variables remained significant as they relate to the others was considered significantly different when P < 0.05.

Results

Univariate t test analysis indicated no significant differences in age, gender, preoperative and postoperative interfragmentary gaps, fracture healing time, and knee function between the two groups (**Tables 1** and **2**). There was significant difference (P < 0.01) in the operation time and operative incision length between the TCCLSTB and TCLS groups. The operation time and incision length in TCLS group are shorter than them in the TCCLSTB group. In the two groups, no complications were observed after the operations. Fractures healed well, and internal fixation showed no loosening or fractures.

There was no difference in the mean postoperative fracture spacing of the articular surface between the TCLS group and the TCCLSTB group (**Table 2**). The mean fracture healing time was the same in the TCLS group as in the TCCLSTB group (**Table 2**). According to the Iowa score criteria [2], the knee function scores were the same in the TCLS group as in the TCCLSTB group (**Table 2**).

Logistic regression showed operation time and incision length were associated with the operation method, with the TCLS group being superior. Because there was no main complication in the two groups, the logistic regression analysis could not show a significant association with the operation method (**Table 3**).

Discussion

In this study, we found that the TCLS technique can do the same good work as TCCLSTB technique in treatment of transverse patella fractures without complication. And simultaneously the TCLS technique needed the shorter operation time, lesser operative incision and cheaper cost than TCCLSTB technique. The fixation of a cable needs longer operation time and bigger operative incision. And also the titanium cable cost additional money. Selecting appropriate and effective methods and materials for treating patellar fractures is a tough challenge for orthopedists [2, 13]. Modified K wires tension band is the most common methods for fixation of transverse patellar fractures [1, 2, 14]. With progressive knee flexion, the cable tension band dynamically converts the tension forces to compressive forces at the articular surface and closes the gap [13]. The latest retrospective comparative study showed TCCLTB technique is superior to modified K wires tension band technique in the treatment of transverse patella fractures [2]. The tatanium cannulated lag screws overcome the disadvantages of K wires so that TCCLSTB technique has less complication than K wires tension band technique in treatment of transverse patella fractures. Moreover, the threaded sectors of cannulated lag screws without cable tension band can give direct interfragmentary compression force to achieve better reduction and to decrease the complications of loosening and migration of implants and skin irritations [13].

The two cannulated lag screws can effectively enhance the interfragmentary pressure which is perpendicular to the fracture, the acting forces on the patellar articular and anterior surfaces are consistent [13]. The probability of cannulated lag screw loosening is very low owing to the dense cancellous bone of the patella and the fact that the distal end of the cannulated lag screw is threaded [13]. But surgeons under operation should drill along the guide pin along the guide wire with a cannulated bit (2.5 mm) before screwing a 4.0-mm titanium cannulated compression screw. Otherwise, the screw would not be screwed into the patella because the bone of the patella is hard and dense.

The aim of operative incision in TCLS technique is only the reduction of patella fracture with the exposure of the fracture line. However, the aims of operative incision in TCCLSTB technique are both of the fixation of titanium cable and reduction of patella fracture, which need us to expose the upper and lower of patella with an anterior longitudinal incision. Therefore, compared with TCCLSTB technique, the lesser transverse operative incision along the fracture line was able to meet the aim in TCLS technique.

In our study, the patients with the two operation methods have no skin irritation and other complications which the patients with modified K-wire tension band technique had suffered from. The reason is that the cannulated lag screws are tightly fixed into the patella with their threaded sectors.

The operation time and operative incision were shorter in the TCLS group. According to the logistic regression analysis, the operation time and operative incision were associated with the operative method. The titanium screws rarely produce adverse effects and won't need to be taken out [2]. The TCLS technique without cable tension band can achieve good fracture reduction and healing with a low rate of complications. The TCLS technique with lesser operative incision saves the time and cost of titanium cable fixation compared with technique in treatment of transverse patella fracture. We therefore recommend its use in treating transverse patellar fractures.

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Disclosure of conflict of interest

None.

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