ORIGINAL PAPER/PŮVODNÍ PRÁCE

Poller K-Wires versus Screws in Distal Tibial Nailing: Non-Inferior Union with Superior Efficiency and Better Alignment

Poller K-dráty versus šrouby při distálním tibiálním hřebování: srovnatelné hojení s vyšší účinností a lepší repozicí

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ABSTRACT

Purpose of the study

To compare the short-term outcomes and complications of the poller screw (PS) and the poller K-wire (PW) in distal tibia nailing.

Material and methods

In the present study, a retrospective analysis was performed on prospectively collected data, 43 cases were included in the study. 16 patients were included in the PS group and 27 patients in the PW group. Demographic data, fracture union times, RUST scores, alignment in the coronal and sagittal planes, associated fibula fractures and fixation, malunion, and complications were compared. A subgroup analysis was performed according to fibula fixation and the number of distal locking screws.

Results

There was no significant difference between PS and PW groups in respect to age, gender, trauma etiology, fracture-joint distance and AO classification of fractures. In the PS group, the operation time and final coronal angulation were significantly higher (operation time: 81.5 ± 15.27 minutes and 72.22 ± 11.79 minutes, respectively, p = 0.031; coronal angulation: 3.12° ± 3.2° and 1.24° ± 1.76°, respectively, p = 0.044). No statistically significant difference was found in terms of fracture healing time and RUST scores. Non-union was observed in one patient in the PS group. There was no significant difference in fracture healing times and RUST scores when subgroup analysis was performed according to fibula fixation and distal locking screw numbers.

Discussion

The PW technique offers significant advantages in terms of surgical efficiency and reduction quality in the coronal plane. Although the risk of wire displacement remains a disadvantage that must be minimised with careful technique, these advantages make PW a preferable alternative to PS for assisting reduction in distal tibial nailing, where PS has disadvantages such as longer operating times and less optimal alignment control.

Conclusions

The use of PW instead of PS has no negative effect on fracture union time and also improves alignment and decreases the operative time.

Key words: distal tibia fracture, intramedullary nailing, poller screw, poller wire, blocking screw, blocking pin.

INTRODUCTION

Intramedullary nailing (IMN) has increased in popularity except for diaphyseal fractures since it allows load sharing, it does not interfere with extraperiosteal circulation, and to increase union rates (9). The use of poller screws (PS) is common to provide reductions and proper alignment in metaphysis fractures. Although widely used in distal tibia fractures, PS also used in proximal tibia, proximal and distal femur metaphysis fractures, exchange intramedullary nailing,

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and cases where deformity correction is performed over the nail (4).

The use of provisional K-wires (PW) instead of poller screws (PS) was first reported in the literature in 2010 (7). The use of K-wires is advantageous over PS, particularly because drilling is often performed on a non-vertical plane when placing poller screws, difficulties in finding the appropriate path after drilling, the screw coming back when placing the nail, the need for more intraoperative radiological imaging, and the prolongation of the operative process and financial burden. However, there are also disadvantages to PW, such as the elastic deformation of K-wires, breakage during removal, and migration of the wire during the drilling process (13). It is particularly interesting to see whether the ideal reduction is compromised when K-wires are used before locking and whether PS have a positive effect on additional stability and healing. The primary objective of our study is to compare poller K-wires and screws in terms of healing time and early reduction results.

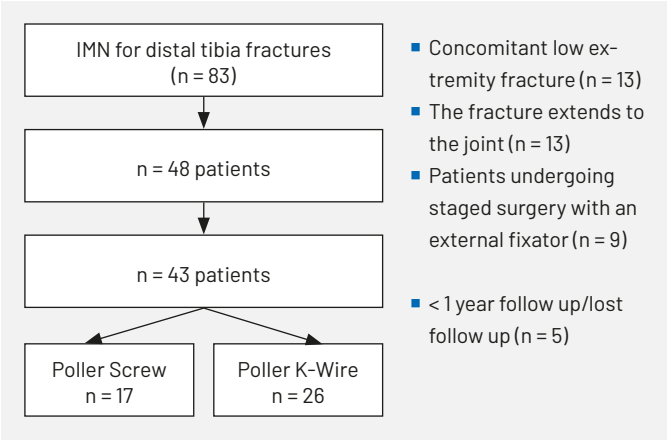

Fig. 1. **Flow chart.**

MATERIAL AND METHODS

Study design and eligibility criteria

After obtaining approval from the IRB and ethics committee, patients who were operated on for distal tibia fractures at tertiary care center in Türkiye, between 2020 and 2024 because of distal tibial metaphysis fractures were retrospectively enrolled. Grade 3 open fractures, pathological fractures, fractures that extended into the ankle joint, cases with fractures in different regions (other than ipsilateral fibula fractures), or cases in which an external fixator was applied before final fixation were excluded. Cases without preoperative ankle CT scans and those with postoperative follow-up of less than one year were also excluded.

A total of 83 patients who had been operated on with intramedullary nails for a distal tibial fracture were retrospectively evaluated. Thirteen cases with other lower extremity fractures, nine cases with prior external fixation, 13 cases with or without fixation since joint involvement, and five cases lost to follow-up were excluded. A total of 43 patients were included in the study (Fig. 1).

Surgical and postoperative management

The surgeries were performed by two trauma surgeons at two different centers. 2 gr of cefazolin was administered as preoperative surgical prophylaxis. The cases were performed in the supine position with the knee in hyperflexion and without tourniquets. All cases were reduced closed. A percutaneous K-wire was applied to the fibula in selected cases to facilitate reduction and provide rotational stability for comminuted tibial fractures at the same level. This technique was, however, avoided in cases with a concomitant comminuted fibula, as fixation in such instances could compromise tibial reduction. Fibula fixation was initially performed using a 2.5 mm Steinman pin with closed reduction and percutaneous fixation. The PS was inserted in the freehand, not through a nail system. PS or PW was sent according to the acute angle if the fracture was spiral (2nd and 3rd generation) and distally to the medial and lateral sides of the distal metaphysis if it was transverse (first generation) before proceeding to the reaming process (Fig. 2) (12). Smooth K-wires with a thickness of 2.5 or 3 mm were selected as PW (Fig. 3). Following the placement of the distal locking scews, the poller K-wires were removed. The infrapatellar patellar tendon split approach was used for nail insertion in all cases. The study period was defined to include a timeframe during which a single, consistent implant design and brand was used at our institution. This approach was chosen to eliminate potential confounding factors associated with variations in implant design and manufacturer. Furthermore, because the specific instrumentation for the suprapatellar approach (e.g., the suprapatellar cannula) was not available for this implant system, cases performed via a suprapatellar technique were excluded from the analysis.

A minimum of two nail locking screws were preferred proximally and distally. The number of distal fixation screws is left to the surgeon's decision; however, three screws are preferred when the fracture is close to the ankle joint and in cases of intraoperatively more unstable fractures. Cases were hospitalized for 24–48 hours after surgery and received analgesia, antibiotics, and venous embolism prophylaxis treatment. Mobilization was provided on the first postoperative day by loading as much weight as tolerated with a double-crutch. In cases where percutaneous fibula fixation was performed, the Steinman pin was removed in the third month if there were no early irritation findings.

Fig. 2. **A 37-year-old female patient presenting with a grade 1 open fracture of the distal tibia following a fall. Preoperative X-rays (a–b); peroperative scopy views: first, after percutaneous fixation of the fibula, the secondary generation poller screw was placed distally only according to the acute angle (c–i); postoperative 5. months X-rays (j–k).**

Union was defined as the fusion of at least three cortices of the fracture line. Non-union was defined as the absence of union for more than 9 months. The RUST score, which is used for fracture union assessment in tibial fractures, was also evaluated (11). A total of four cortices were evaluated in the coronal and sagittal planes; if there was no callus, 1 point was given; if there was callus and the fracture line was visible, 2 points were given; if there was callus but no fracture line, 3 points were given, and the total score was evaluated. Angulation of more than 5 degrees in the coronal plane and 10 degrees in the sagittal plane and shortening more than 1 cm were considered malunion. Patients were evaluated in respect to union time, fracture type according to the AO classification, nail diameter used, number of distal locking screws, follow-up periods, final follow-up AOFAS score, distance of the fracture distal from the plafond, accompanying fibula fracture and its treatment. Patients were also evaluated for anterior knee pain, infection and malunion requiring reoperation.

Statistical analysis

All statistical analyses were performed using the SPSS ver.22.0 statistics software program (IBM Corp., Armonk, NY, USA). The suitability of the quantitative data for normal distribution was tested by Shapiro–Wilk test and graphical evaluations. Descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum and maximum) were used to evaluate the study data. Student's t-test was used to compare two groups of quantitative data with normal distribution, and Mann–Whitney U test was used to compare two groups of data with non-normal distribution. Pearson

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Fig. 3. **A 29-year-old patient presenting with a distal tibial fracture following a fall down the stairs. preoperative X-rays (a); intraoperative fluoroscopic images, the poller K-wire was placed distally only according to the acute angle (b–c); migration of the wire posteriorly during nail placement (c); postoperative X-rays (d–e).**

chi-square test and Fisher's exact test were used to compare qualitative data. $P < 0.05$ was considered to indicate a statistically significant difference.

RESULTS

The study included 26 male and 17 female patients with an average age of 38 years (minimum: 18, maximum: 65). The mechanisms of injury were evaluated, with 22 cases due to falls from height and 19 cases due to traffic accidents. Ten patients had grade 1 and 2 open fractures. Definitive treatment was performed without the use of external fixators in these patients. Type 42A fractures were present in 26 of the 43 patients included in the study. Among these, the most common were type 42A1 fractures with a spiral fracture line (27%) and type 42A2 fractures with an oblique fracture line (25%). The distance of the fracture line from the joint line on the ankle mortis radiograph was 73.38 ± 16.97 mm on average (minimum: 34 mm, maximum: 109 mm) (Table 1) . In 25 patients (58%), the number of distal locking screws was two, while in 18 patients (42%), it was three. Accompanying ipsilateral fibula fractures were present in 31 cases, but only nine of these cases were fixed percutaneously. According to the poller implant used to assist closed reduction, screws were used in 16 cases and K-wires in 27 cases.

There was no significant difference between PS and PW groups in respect to age, gender, trauma etiology, and AO classification of fractures. In the PS group, the distance of the fracture line from the joint was found to be insignificantly shorter (68.4 ± 15.3 mm and 76.31 ± 17.5 mm, respectively, p = 0.143). The tibial nail thickness and number of distal locking screws used in both groups were not significantly different. In the PS group, the operation time was significantly longer than in the PW group (81.5 ± 15.27 minutes and 72.22 ± 11.79 minutes, respectively, p = 0.031). The mean time to fracture union was not significantly different between two groups, with the PS group union approximately one week earlier (19.12 ± 5.97 weeks vs. 18.37 ± 15.09 weeks, p = 0.781). The coronal plane angulations at the final follow-up were evaluated, and it was found that the PS group had significantly greater angulation (3.12° ± 3.2° and 1.24° ± 1.76°, respectively, p = 0.044). No significant differences were observed between the two groups in terms of final follow-up AOFAS scores, RUST scores, and sagittal plane angulation (Table 2).

Table 1. **Demographic and baseline data**

		GROUP			TEST VALUE
		PS (N = 16)	PW (N = 27)	TOTAL (N = 43)	P
Age	Mean±Sd	35.87 ± 14.91	39.26 ± 14.579	38.02 ± 14.75	[a]**0.469**
Gender	**Male**	12 (75)	14 (51.8)	26(60.4)	[c]**0.133**
	Female	4 (25)	13 (48.2)	17 (39.6)	
Trauma (%)	**Traffic accident**	7 (43.8)	12 (44.4)	19 (44.2)	[d]**0.161**
	Fall	7 (43.8)	15 (55.6)	22 (51.2)	
	Other	2 (12.5)	0	2 (4.7)	
Open fracture (%)		4 (25)	6 (22)	10 (23)	[d]**0.558**
Classification	**A (1-2-3)**	4/2/1	8/9/2	12/11/3	[d]**0.155**
	B (2-3)	4/1	5/1	9/2	
	C (2-3)	3/1	2/0	5/1	
Fracture line-Ankle distance (mm)	Mean ± Sd	68.4 ± 15.3	76.31 ± 17.5	73.38 ± 16.97	[a]**0.143**

Sd, standard deviation; mm, milimeter; PS, poller scew; PW, poller k-wire
[a]Data analyses were performed with Independent Samples T-test
[b]Data analyses were performed with the Mann-Whitney U test
[c]Data analyses were performed with Pearson Chi-Square test
[d]Data analyses were performed with Fisher's Exact Test
*p < 0.05

Table 2. **Mean time to recovery, follow-up**

		GROUP			TEST VALUE
		PS	PW	TOTAL	P
Nail diameter	Mean ± Sd	11.12 ± 0.8	11.07 ± 0.8	11.09 ± 10.81	[a]**0.845**
Fibula fracture (%)		12	19	31	[d]**0.515**
Fibula fixation (%)		3	6	9	[d]**0.554**
Distal locking screw	Mean ± Sd	2.43 ± 0.51	2.4 ± 0.5	4 (9.5)	[b]**0.848**
Operation time	Mean ± Sd	81.5 ± 15.27	72.22 ± 11.79	75.67 ± 13.78	[a]**0.031***
Final ML angulation	Mean ± Sd	3.12 ± 3.2	1.24 ± 1.76	1.94 ± 2.56	[b]**0.044***
Final lateral angulation	Mean ± Sd	1.43 ± 1.71	1.2 ± 2.41	1.29 ± 2.16	[b]**0.268**
Follow-up (month)	Mean ± Sd	20.68 ± 8.91	19.37 ± 9.03	19.86 ± 8.9	[b]**0.585**
Union time (week)	Mean ± Sd	19.12 ± 5.97	18.37 ± 15.09	18.65 ± 5.38	[b]**0.781**
RUST score	Mean ± Sd	9.43 ± 1.59	9.77 ± 1.39	9.65 ± 1.46	[b]**0.643**
Malunion (%)		6 (37)	4 (14)	10 (23)	[d]**0.535**
Anterior knee pain (%)		3 (18)	5 (18)	8 (18)	[d]**0.545**
Shortening	Mean ± Sd	3.01 ± 3.84	3.40 ± 2.97	3.25 ± 3.28	[a]**0.700**
AOFAS	Mean ± Sd	88.2 ± 8.41	87.85 ± 8.07	88 ± 8.1	[a]**0.878**

Sd, standard deviation; ML, mediolateral; PS, poller scew; PW, poller k-wire
a Data analyses were performed with Independent Samples T-test
b Data analyses were performed with the Mann-Whitney U test
cData analyses were performed with Pearson Chi-Square test
dData analyses were performed with Fisher's Exact Test
*p < 0.05

Subgroup analysis was performed on 31 cases of fibula fracture, divided into two groups based on percutaneous fibula fixation. Although the average surgery time was significantly longer by 13 minutes, no significant difference was found in terms of the distance of the fracture line from the joint, fracture union time, RUST scores, and AOFAS scores at final follow-up, or in terms of angulation in the coronal and sagittal planes (p > 0.05) (Table 3).

There was no significant difference in fracture union, RUST score and operation times between the two subgroups based

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Table 3. **Subgroup analysis based on fibula fixation and the number of distal locking screws**

		FIBULA FIXATION (N = 31)			SUBGROUP ACCORDING TO DISTAL LOCKING SCREW NUMBER (N = 43)		
		FIXED (N = 9)	NONE (N = 22)	P	2 SCREW (N = 25)	3 SCREWS (N = 18)	P
Pollar type	**PS**	3 (33)	9 (41)	[d]**0.511**	9 (36)	7 (38)	[d]**0.548**
	PW	6 (67)	13 (59)		16 (64)	11 (62)	
Fracture line-Ankle distance (mm)	Mean ± Sd	66.01 ± 17.86	74.34 ± 19.11	[a]**0.271**	75.28 ± 18.76	70.75 ± 14.22	[a]**0.395**
Operation time	Mean ± Sd	87.22 ± 10.03	74.5 ± 12.90	[a]**0.013***	74.40 ± 13.6	77.44 ± 14.18	[a]**0.482**
Final ML angulation	Mean ± Sd	1.22 ± 1.32	2.20 ± 2.93	[b]**0.575**	1.76 ± 2.41	2.19 ± 2.82	[b]**0.711**
Final lateral angulation	Mean ± Sd	1.03 ± 1.8	2.12 ± 2.61	[b]**0.238**	1.26 ± 1.64	1.33 ± 2.71	[b]**0.533**
Union time (week)	Mean ± Sd	19.44 ± 6.57	18.55 ± 4.9	[b]**0.776**	17.96 ± 5.44	19.61 ± 5.23	[b]**0.327**
RUST score	Mean ± Sd	9.44 ± 2.06	9.59 ± 1.29	[b]**0.876**	9.76 ± 1.26	9.5 ± 1.72	[b]**0.840**
Malunion (%)		1 (11)	7 (31)	[d]**0.235**	5 (25)	5 (38)	[d]**0.406**
AOFAS	Mean ± Sd	89.55 ± 10.13	87.59 ± 8.51	[a]**0.585**	88.88 ± 8.25	86.77 ± 7.95	[a]**0.408**

Sd, standard deviation; ML, mediolateral; PS, poller scew; PW, poller k-wire
a Data analyses were performed with Independent Samples T-test
b Data analyses were performed with the Mann-Whitney U test
cData analyses were performed with Pearson Chi-Square test
dData analyses were performed with Fisher's Exact Test
*p < 0.05

on the number of distal locking screws (although the average time was 3 minutes longer with 3 screws). The distance to the joint was higher in the three-screw group compared to the two-screw group, but no significant difference was detected. (70.75 ± 14.2 mm and 75.28 ± 18.76 mm, respectively, p = 0.394).

In cases with an average follow-up of 19 weeks, non-union was observed in only one patient in the PS group over a 13-month period. Exchange nailing was recommended for this patient, but the patient declined. Anterior knee pain was present in three patients in the PS group and five patients in the PW group. Asymptomatic malunion was observed in 6 patients in the PS group and 4 patients in the PW group, with no statistically significant difference (p = 0.535). In 6 cases, valgus of more than 5 degrees in the coronal plane was detected, procurvatum of more than 10 degrees in one case, and shortening of more than 1 cm in three cases. Superficial infection was observed in one case with a grade 2 open fracture. It was treated with systemic antibiotic therapy without the need for debridement. Intraoperative new fracture line occurrence was observed in only two cases in the PS group; union was achieved in these two cases.

DISCUSSION

This study demonstrates the distinct advantages of poller K-wires (PW) over screws (PS). The main advantages of PW are a statistically significant reduction in operating time and improved coronal alignment. These advantages can be attributed to the dynamic and easy-to-apply nature of the technique. PW contributes to indirect reduction with less cortical stress by allowing simple and repositioning. In contrast, the disadvantages of PS include the technical difficulty of achieving bicortical purchase due to the angled placement of the screws on the tibial cortex and the challenge of reliably engaging the opposite cortex and longer operating times. However, one of the disadvantages of using K-wires is that even when held with a clamp, the wire can advance after reaming and cause neurovascular damage (Fig. 3). The use of PS did not provide a significant difference compared to PW in terms of fracture union time and RUST and AOFAS scores.

In a meta-analysis comparing plates and intramedullary nails for the fixation of extra-articular fractures of the distal tibia, it was found that fracture union and weight-bearing times were shorter with nails, while anterior knee pain and malunions were more common. Considering that plate applications carry a higher risk of infection, especially in patients with soft tissue problems such as open fractures, intramedullary nails are preferred. However, since union outcomes are similar except for complications, implant selection should be personalized in treatment (10). In a biomechanical study comparing plates, IMN, IMN, and poller screws in distal tibial fractures, it was demonstrated that the addition of a poller screw reduces shearing forces and interfragmentary movement, thereby increasing stiffness (2).

The use of PS aims to increase stability by narrowing the intramedullary canal in transverse fractures, while in oblique and spiral fractures, they are used to improve alignment, reduce shearing forces, enhance healing, and prevent malunion (13). In a biomechanical study conducted to demonstrate the effect of the poller screw in distal tibial fractures, cadaver bone models locked with 2 or 3 screws distally were evaluated

in the group with the poller screw added. No significantly faster union time was found compared to the other groups (3). In a retrospective study evaluating the effect of PS use on fracture union time and malunion in cases treated with intramedullary nails since distal tibial fractures, the group using PS (n = 21) showed significantly higher union rates and RUST scores and fewer malunions compared to the control group (n = 72) (1).

In a biomechanical study evaluating the effect of ipsilateral fibula fracture on the fixation of distal tibial fractures, half of the 16 cadavers underwent locked plate fixation and the other half underwent internal fixation. Although there was no significant difference in stiffness between the two groups before fibula osteotomy, fibula osteotomy performed at the same level resulted in a significant decrease in stiffness in both groups, and the group treated with a locked plate was found to have significantly higher stiffness than the group treated with an intramedullary nail (8).

The use of PW instead of PS was first described in the literature by Abdulsalam et al. in 2010 (7). A 3 mm Steinman pin was temporarily placed in the shorter distal fragment before reaming for the nail. After placing the distal and proximal nail locking, the Steinman pin was removed and screw inserted. The author also recommended holding the screw with a clamp to prevent pin migration. In 2016, Poyanlı et al. presented the results of their study on PW in distal femur fractures and proximal and distal metaphysical tibia fractures. In their study, one of the 13 patients developed asymptomatic malunion, and union was achieved in all patients. They stated that K-wires with a provisional 3 mm diameter can be used comfortably by dynamically repositioning them, preventing unnecessary tissue dissection and avoiding new fractures that may occur at the fracture line when placing the poller screw (6).

In another study comparing poller screws and K-wires, fracture union time and complications were evaluated. In the PW group, no significant difference was observed in fracture union times or malunion compared to the PS group; however, it was noted that operating times and fluoroscopy times were significantly higher. Although similar results were observed in our study, a significant increase in final coronal plan angulation was detected in the PS group. This can be explained by the more dynamic adjustment of pin placement in the PW group (5).

There are several limitations to this study. The retrospective nature of the study and the small sample size are some of these limitations. More specific studies on the application of pollers (in terms of generation) and distal tibia fracture subgroups could make the results more meaningful. Suprapatellar approach reduction is easier in distal and proximal tibial fractures and reduces complications such as anterior knee pain. For distal tibia fractures, the suprapatellar nailing technique has been shown to achieve better fracture alignment and higher functional scores compared to the infrapatellar approach (12). The results of poller application should also be evaluated in this group. Randomized controlled trials with large sample groups are needed to compare poller application and poller implants in distal tibial fractures, which are not found in the literature.

CONCLUSIONS

In conclusion, the present study found that the use of PW shortens the duration of surgery compared to the use of PS and does not have a significant effect on union time. No significant differences were observed between the two groups in terms of functional scores, complications, and RUST scores. The use of PW demonstrated better results in the final mediolateral alignment. In distal tibial fractures, a clear recommendation can be made in favor of the posterior K-wire (PW) technique over the posterior screw (PS) technique for intramedullary nailing of distal tibial fractures. ■

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