Comparison of Free-hand and K-wires Technique in Distal Locking of Expert Tibia Nail

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ABSTRACT

The purpose of this study was to analyse the application value of K-wires technique for distal locking of expert tibia nail (ETN). It was a retrospective study carried out from September 2019 to July 2020 at the First Affiliated Hospital of Jinzhou Medical University. All the patients of distal tibial fracture, treated with the ETN and free-hand or K-wires technique for distal locking, were included in this study. A total of 98 patients were evaluated, which included 47 with free-hand and 51 with K-wires technique. The operation time of the K-wires technique was shorter than that of free-hand ($p < 0.001$). The number of distal shots, distal locking time, and the total number of shots with K-wires technique were lower than those with free-hand ($p=0.015$, $p=0.025$, and $p=0.030$, respectively). The adjustment time for the K-wires was less than that by free-hand ($p=0.001$). The K-wires can be better used for the distal locking of the ETN.

Key Words: *Distal locking, Tibia fractures, Intramedullary nail.*

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The ETN is widely used for minimally invasive treatment of distal tibial fracture.[1] But distal locking of ETN is one challenging step that could be time-consuming and radiation-exposing because of nail deformation, screw misalignment, and positioning difficulties. The common proximal mounted distal targeting device does not compensate for the nail deformation during insertion through distal tibial medullary canal.[2] To solve these problems, manufacturers have developed numerous innovative techniques, such as robotic and electromagnetic rays. However, they have not been widely used due to the cost and availability. The free-hand is still the final solution after all the other methods fail.[3]

Considering the above problems, the distal locking was simplified by inserting K-wires of different sizes. The purpose of this study was to analyse the application value of the K-wires technique in distal locking of ETN, in order to provide a reference for solving the problem of distal locking in the treatment of distal tibial fractures with ETN.

This retrospective study was carried out at the First Affiliated Hospital of Jinzhou Medical University, China, from September 2019 to July 2020. The study was conducted after approval from the Hospital Ethical Committee (No. 202259).

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Patients clinically diagnosed as distal tibial fracture, treated with the ETN and free-hand or K-wires technique for distal locking, were included. Patients combined with obsolete fracture, open fracture, and previous surgery on the affected tibia were excluded.

For the free-hand technique, distal locking of the ETN was locked as the described standard procedures.[4] For the K-wires technique, different sizes were used to guide the insertion of the distal locking screws. First, a 2.0 K-wire was inserted into the distal locking hole. The 2.0 K-wire was then replaced with the 3.0 K-wire to enlarge the hole. Finally, the 3.0 K-wire was pulled out and a locking screw was screwed in to achieve distal locking. The preoperative demographic factors, intraoperative data, and postoperative evaluation were compared between the two groups. Collected data were analysed using student's t-test and chi-square test by SPSS 26.0 (IBM, USA). And p-value <0.05 was considered as significantly different.

A total of 98 cases, according to different distal locking methods, were divided into two groups, free-hand (n=47) and K-wires technique (n=51). There were no significant differences regarding preoperative demographic factors ($p > 0.05$), as shown in Table I.

Intraoperative and postoperative information are also summarised in Table I. The operation time with K-wires technique was shorter than with free-hand ($p < 0.001$). The difference in the healing time was not statistically significant ($p=0.136$). The distal shooting number, distal locking time, and the number of shots with K-wires technique were lower than those with free-hand ($p=0.015$, $p=0.025$, and $p=0.030$, respectively). In this study, the average parameters for distal locking were within the range reported in the literature.[3,5]

Table I: Preoperative / intra- and postoperative.

	Free-hand (n=47)	K-wires technique (n=51)	p-value
Age (years)	47.87±15.78	48.20±15.32	0.918[a]
Gender n (%)			0.911[b]
Female	17 (36.17%)	19 (37.25%)	
Male	30 (63.83%)	32 (62.75%)	
Side n (%)			0.326[b]
Right	24 (51.06%)	21 (41.18%)	
Left	23 (48.94%)	30 (58.82%)	
Trauma mechanism n (%)			0.857[b]
Traffic Accident	18 (38.30%)	17 (33.33%)	
Sports-related	18 (38.30%)	22 (43.14%)	
Work-related	11 (23.40%)	12 (23.53%)	
Fibula fracture n (%)			0.926[b]
Combined	18 (38.30%)	20 (39.22%)	
Uncomplicated	29 (61.70%)	31 (60.78%)	
AO classification n (%)			0.507[b]
43-A	20 (42.55%)	26 (50.98%)	
43-B	16 (34.04%)	12 (23.53%)	
43-C	11 (23.40%)	13 (25.49%)	
Operation time (minutes)	133.34±22.54	113.82±23.87	<0.001[a]
Healing time (weeks)	15.15±1.30	14.73±1.47	0.136[a]
Distal shooting number	28.94±4.60	26.53±5.00	0.015[a]
Distal locking time (min)	30.26±4.47	27.82±5.93	0.025[a]
The total number of shots	92.21±25.70	82.06±18.86	0.030[a]
The adjustments time	2.98±1.34	1.53±0.61	<0.001[a]
AOFAS			
3 months	82.38±4.55	81.88±5.03	0.515[a]
6 months	86.94±3.65	86.76±3.61	0.816[a]
12 months	90.74±2.49	90.51±3.30	0.690[a]
24 months	92.60±2.73	93.29±3.00	0.233[a]

[a]*Student's t-test,* [b]*Chi-square test.*

The K-wires technique effectively reduces distal locking relevant parameters and to a certain extent, radiation exposure. All targeting adjustments were successful within 2 tries with the K-wires technique, which was statistically significant (p <0.001). When comparing the AOFAS scores between the two groups, similar outcomes were obtained at 3, 6, 12, and 24 months of follow-up (p=0.515, p=0.816, p=0.690 and p=0.233, respectively). Overall, the K-wire technique does not affect the postoperative recovery as reflected by the healing time and AOFAS scores between the two groups.

When using free-hand for distal locking, the authors found that the drill-bit tip was often not sharp due to the repeated use. The authors improved the free-hand technique for distal locking by inserting K-wires of different sizes. The main reason is that the K-wires are cheap and easily accepted by patients. Meanwhile, the tip of the 2.0 K-wire is thinner than the drill-bit and easier to drill into smaller spaces. Furthermore, the tip of the K-wire is tapered, which makes it difficult to slip out of the hole to easily adjust the position and direction of the K-wire.

In the process of replacing the K-wires of different sizes, the position and direction of the K-wires need to be maintained. A slight deviation may cause the K-wire to not find its previous trajectory. If the position of the K-wire is adjusted too many times, it may lead to affect the distal locking effect. The K-wires technique requires repeated drilling by replacing the different sizes of K-wires to enlarge the locking hole. Therefore, drilling should be done slowly with the K-wire to avoid burn damage or iatrogenic fracture.

All in all, with a minimum of two years follow-up, the K-wires technique proved comparable safety to the free-hand technique including similar healing time and AOFAS scores. Meanwhile, The K-wires technique effectively reduces distal locking relevant parameters and, to a certain extent, radiation exposure. In addition, the K-wire technique does not require other specific instrumentation and allows the operator to choose any manufacturer's nail.

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ETHICAL APPROVAL:
This retrospective observational study was reviewed and approved by the Ethical Committee of the First Affiliated Hospital of Jinzhou Medical University (Approval No. 202259).

PATIENTS' CONSENT:
Since it was designed as a retrospective study, the data

were collected from the hospitals' archive after approval of the ethics committee.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
YS: Wrote the manuscript and collected the data.
YW: Designed this study and participated in revising the paper.
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