

# A Novel Device for Accurate Guide wire Placement in Cannulated Screw Fixation of Femoral Neck Fracture:A Pilot Study

bu-fang ren (✉ [rbfdlh123@163.com](mailto:rbfdlh123@163.com))

department of orthopedics, the second hospital of shanxi medical university, 382 wuyi road ,taiyuan shanxi province, china

quan-ping Ma

department of orthopedics,the second hospital of shanxi medical university

xin lv

department of orthopedics,the second of shanxi medical university

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## Research article

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# Abstract

**Background:** Accurate placement of cannulated screws is the key to stable fixation of the femoral neck fracture. A novel device was developed to improve the accuracy of screw placement.

**Methods:** 20 synthetic femoral bones were divided into conventional technique group and the experimental group. Three Kirschner wire were inserted into the femoral neck fracture by conventional technique or by the simple guide device. The operative time, total drilling times and fluoroscopic frequency were evaluated.

**Results:** By using the guide device, the fluoroscopy and operation time of the experimental group were shorter that of the conventional method. The total drilling times with the simple guide device were significantly lower than the conventional technique group.

**Conclusions:** This device can help trauma surgeons shorten the surgical time and reduce radiation exposure time. The use of this guide device can make screw fixation for femoral neck fracture easier.

## Background

Femoral neck fracture is a common hip fracture in orthopedics. Internal fixation is preferred for femoral neck fracture in young people and non-displaced femoral neck fracture in elderly people with good physical condition<sup>1,2</sup>. Cannulated screws has been an accepted implant among several implants which have been used for femoral neck fracture<sup>3,4,5</sup>. Placing three cannulated screws in parallel with the inverted triangle can provide better biomechanical stability<sup>6</sup>. However, it is not easy for the surgeons to place screws at the right position. Accurately to insert guide wires accounts for a significant proportion of the total fluoroscopy and operative time.

In this study, the authors designed a novel device for accurate placement of guide wires in cannulated screw fixation of femoral neck fracture. The purpose of this study was to demonstrate the effectiveness of the guide device.

## Methods

### Structure of the device

The device consists of two components: Aiming component and fixation component (Fig1). Aiming component (Fig1B) consists of a damping, a rod and two meshes, which were welded on the two opposite sides of the damping (Fig1B). The collodiaphyseal angle can be adjusted by opening or closing of the damping. The holes in the meshes are 3 mm in diameter and 2 mm apart. The two meshes correspond exactly, and the corresponding holes form a pipe which permits a Kirschner wire pass through. Fixation component (Fig1A) includes two stainless steel buckles and a small steel plate. The two buckles were welded to the plate. The buckle has a hole, through which rod of aiming component

passed and tightened by locking knob. The rod can be rotated in the hole to adjust the angle of anteversion. There are four holes in each side of the plate by which the plate was sutured on the thigh.

20 synthetic femoral bone were obtained from (Osborne Technology Co, Ltd, Hangzhou, China). The specimen was covered with sponges to simulate the soft tissue compartment and divided into conventional technique group and the experimental group.

In the conventional technique group, a guidewire was placed along the anterior femoral neck as a reference. The first Kirschner wire was inserted to femoral neck manually. Fluoroscopic imaging was performed and once it was in the inferocentral part of femoral neck, use a parallel guide to place the posterosuperior and anterosuperior Kirschner wire.

In the experimental group, the guide device was sutured on the lateral side of the thigh and the Kirschner wires were inserted through the pipe onto the lateral femur cortex (Fig2). Anteroposterior and lateral fluoroscopic images were acquired. The trajectory of the Kirschner wires in the femoral neck is judged according to the extension of image of Kirschner wire on the c-arm fluoroscope (Fig3A,3B). The Kirschner wires were drilled into the femoral neck when they were in the right location (Fig3C, D).

## Statistical Analysis

This was carried out using SPSS18.0 software (SPSS Inc., Chicago Illiosi) using chi-squared testing. The level of significance was set as a p-value<0.05.

## Results

The operative time with the novel device were significantly lower than the operation with the conventional technique ( $p \leq 0.05$ ). The fluoroscopic frequency and total drilling times were also significantly lower in the operation with the novel device ( $p \leq 0.001$ ).

Table 1  
comparison of results in the two groups

Result	Experimental group	Conventional group	P
Operation Time (min)	20.8 ± 8.1	38.3 ± 5.6	0.04
Fluoroscopy Frequency(number)	6.5 ± 3.6	16.7 ± 8.4	$\leq 0.001$
Total drilling times	4.5 ± 0.6	16.9 ± 4.2	$\leq 0.001$

## Discussion

Closed reduction and internal fixation have become the standard methods for the treatment of femoral neck fractures in patients 60 years of age or younger. Fixation with three parallel cannulated screws placed in an inverted triangle configuration, is a common method for femoral neck fracture<sup>7</sup>. If complication didn't occur, the patient can resume normal activities. The inverted triangle is effective in reducing the rate of nonunion and implant failure<sup>8</sup>. However, accurate guide wire placement necessitates high requirement for the surgeon and requires more fluoroscopic and operative time. So, we developed this device to make it easier.

The conventional method of screw placement for femoral neck fractures is mainly performed by surgeons with experience under fluoroscopic monitoring. During the screw fixation of femoral neck fracture with closed reduction, the femoral neck was not exposed and the desired position was not easily obtained due to the lack of necessary reference during the placement of the first guide needle, which often requires multiple drilling for success. Multiple drilling not only resulted in prolonged operation time, increased tissue damage, and increased doctor-patient exposure time to the X-ray radiation, but also resulted in unstable fracture fixation due to more or less osteoporosis in the femoral neck of most patients<sup>9</sup>.

By using the guide device, the fluoroscopy and operation time of the experimental group were shorter than that of the conventional method. The most important thing is to successfully insert the guide wires in the femoral neck at one time. The femoral cortex was not drilled frequently.

The guide device is easy to operate. It works like inserting the spiral blade in the proximal femoral nail anti-rotation system. When the device is sutured on the lateral side of the thigh between the anterior and posterior femur cortex, three Kirschner wire were inserted onto the cortex of femur. Anteroposterior and lateral fluoroscopic images were acquired. The trajectory of the Kirschner wire in the femoral neck was judged according to the extension of image of Kirschner wire on the c-arm fluoroscope. The collodiaphyseal angle can be adjusted by opening or closing of damping. The angle of anteversion can be adjusted by rotating the rod in steel buckle. Once the Kirschner wires were in right place, they were drilled into the femoral neck.

Other researchers have developed guides to accurately place Kirschner wires. Yin et al. demonstrated a novel guidewire aiming device to improve the accuracy of guidewire Insertion<sup>10</sup>. However, the operation was complicated. The navigation systems could improve accuracy<sup>11,12,13</sup> but the higher costs of the special instruments and increased radiation and operative time limited their clinical use<sup>14</sup>.

## Conclusions

This guide device can significantly improve the accuracy of injection, reduce tissue damage, shorten the operation time and reduce the amount of X-ray radiation, and has less dependence on the operator's experience. The use of this device can make percutaneous compression hollow screw fixation for femoral neck fracture easier.

We believe this guide device can help to promote screw fixation technique in third world countries. This is helpful for an inexperienced hand.

## **Declarations**

### **Ethics approval and consent to participate**

The study was approved by the Institutional Review Board/Ethics Committee of the second Hospital of Shanxi Medical University. The study was conducted according to the ethical principles stated in the Declaration of Helsinki

### **Consent for Publication**

The participants declare that they agree to publish the data described in the manuscript.

### **Availability of data and material**

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request

### **Competing interests**

The authors declare that they have no competing interests.

### **Funding**

Not applicable

### **Authors' contributions**

Not applicable

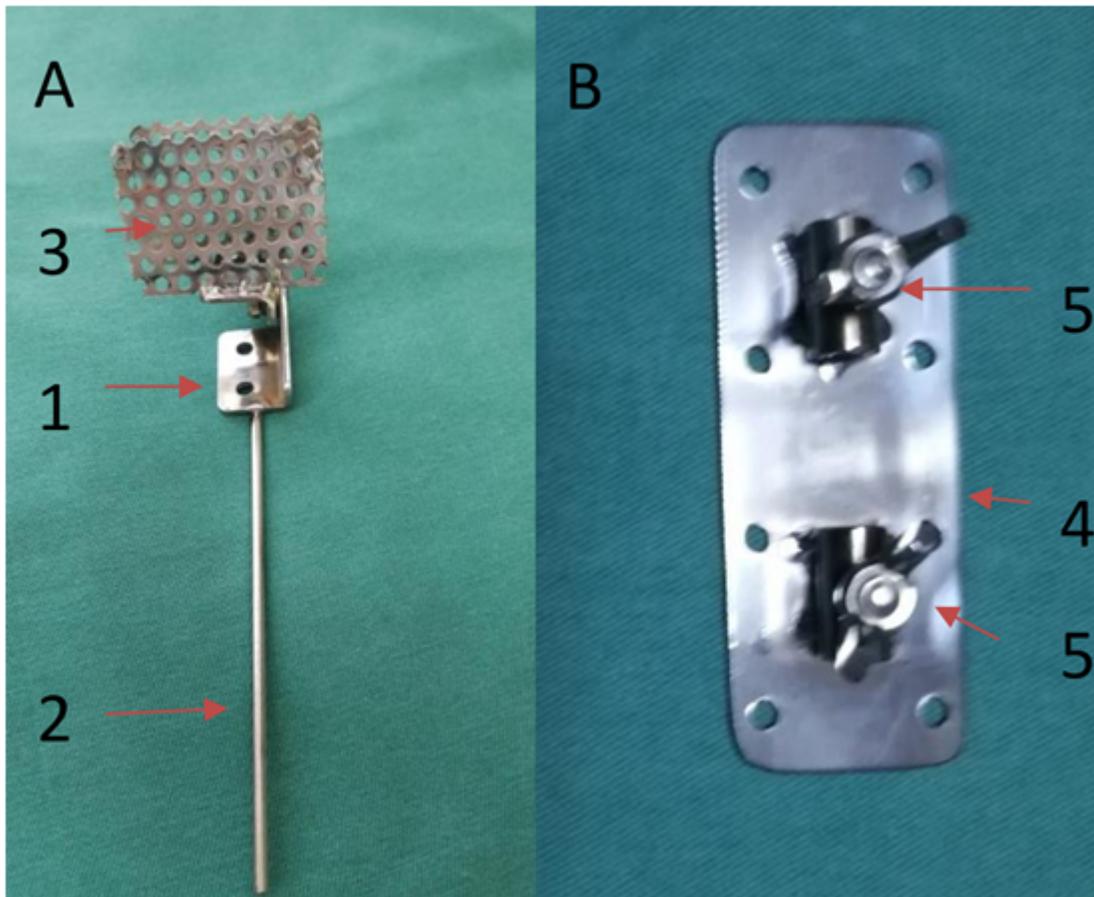
### **Acknowledgements**

Not applicable

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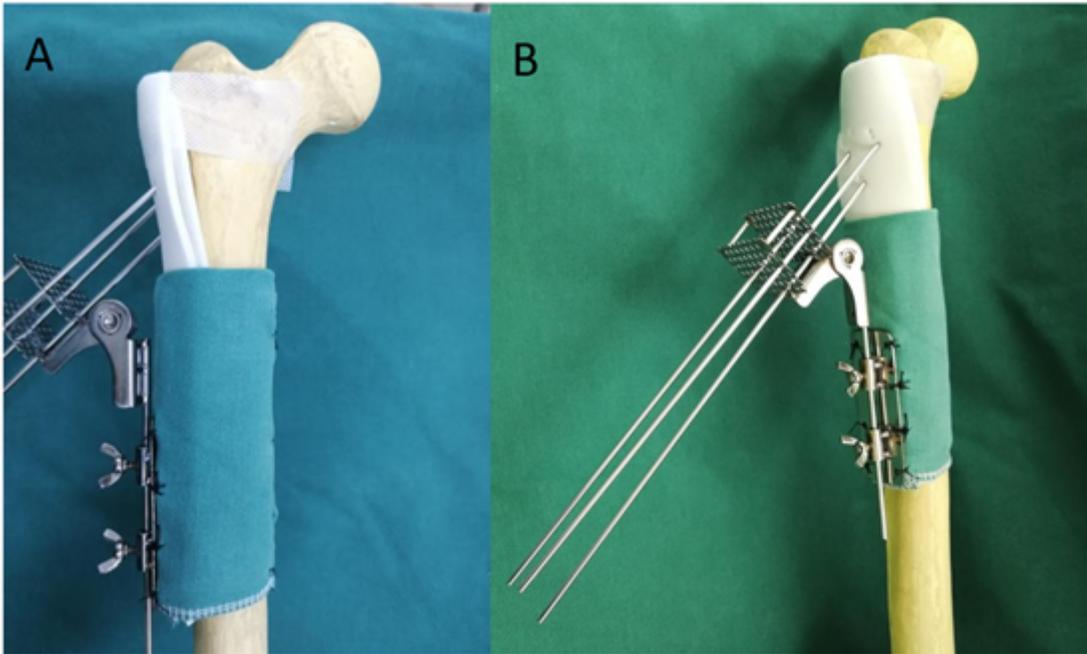
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## Figures



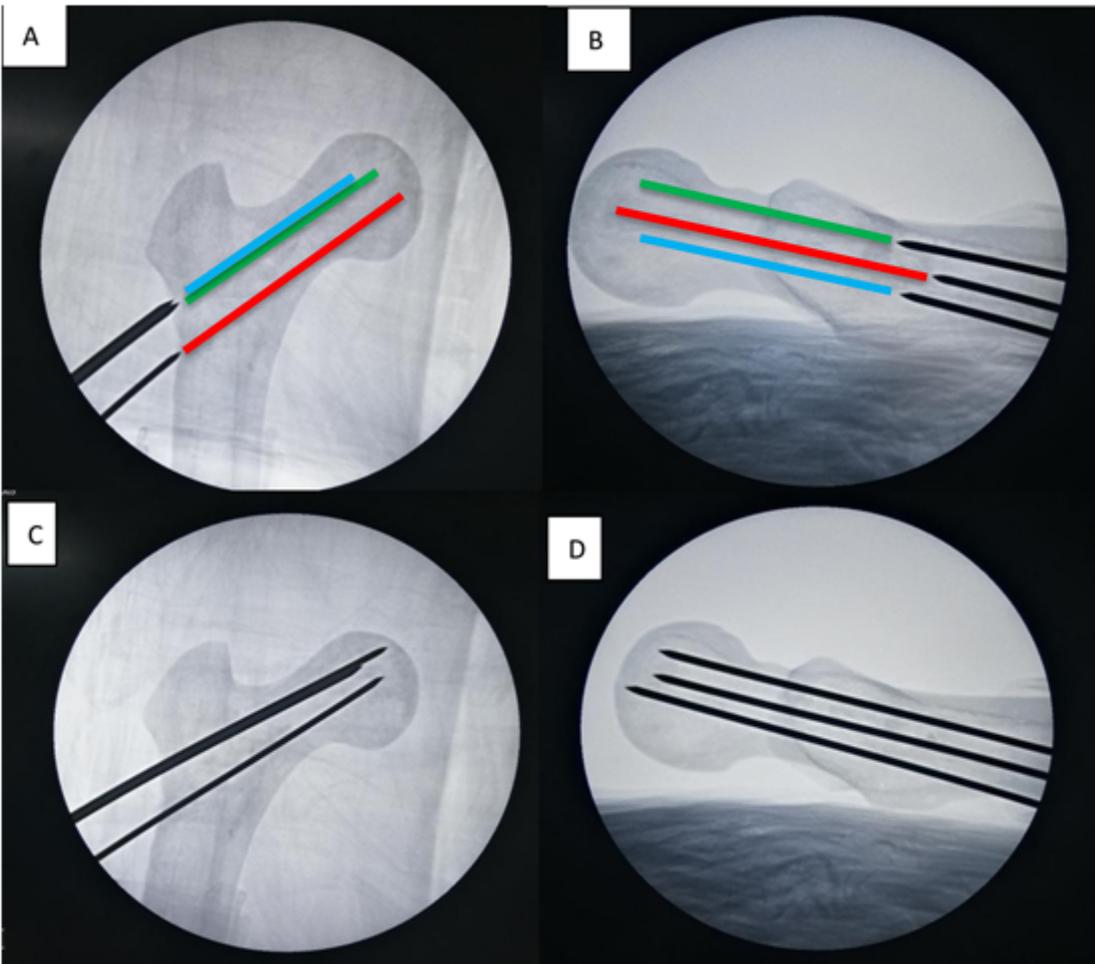
**Figure 1**

Picture of the guide device. (A) aiming component consists of damping (1), a rod (2) and two meshes (3), which were welded on the two opposite sides of the damping. (B) fixation component: two stainless steel buckle(4), which has a hole and locking knob, are welded to a small steel plate (5).



**Figure 2**

The guide device was fixed on the surface of the skin. The three Kirschner wire through the pipe was inserted onto the surface of the femur. (A: Anterior view, B: lateral view).



### Figure 3

Insertion of the three Kirschner wire: Anteroposterior(A) and lateral (B) fluoroscopic images were acquired. The trajectory of the Kirschner wires (the red, green and blue lines in the A, B) in the femoral neck is judged according to the extension of image of Kirschner wires on the c-arm fluoroscope. The Kirschner wires were drilled into the femoral neck (C, D).