Application of Proximal Tibial Bone Cutting Block Without Guide Rod In Total Knee Arthroplasty: A Technical Note

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Research Article

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Abstract

Background The tibial bone cutting can affect the postoperative mechanical axis (MA), joint function and prosthesis life in total knee arthroplasty (TKA). Traditional intramedullary or extramedullary positioning systems have the possibility of embolization, difficulty in positioning and prolonged operation time. A bone cutting guide block with a fixed posterior slope angle (PSA) also may change the original physiological PSA.

Methods We describe a tibial bone cutting technique with the help of a new tibial bone cutting guide block without a positioning rod. The positioning plate and metal probe were used to determine the PSA and thickness of bone cutting by preoperative X-ray measurement according to the preoperative measurement.

Results The tibial bone cutting block without guide rod can keep the physiological PSA, reduce the error and operating time of the traditional positioning method in surgery.

Conclusion This technique may be a good option for TKA patients, especially those with tibial deformities.

Trial registration: retrospectively registered

Background

Total knee arthroplasty (TKA) is an effective method for the end-stage knee osteoarthritis (KOA). The correct direction and thickness of the tibia bone cutting are associated with the success of the operation [1, 2]. Proper posterior slope angle (PSA) can achieve the femoral condyle rollback motion [3, 4]. The thickness of the medial and lateral tibia bone cutting affects the balance of soft tissue. Therefore, the results of the tibial bone cutting affect the postoperative knee joint and prosthesis function. The proximal tibia bone cutting guide system can be divided into intramedullary and extramedullary guides. During intramedullary positioning, the surgeon inserts the intramedullary rod into the tibial medullary cavity, which may not be able to be inserted. In addition, the intramedullary positioning rod can cause fat embolism and venous thromboembolism [5]. Until now, extramedullary positioning rod is mostly used for proximal tibial bone cutting. Place the tibial extramedullary cutting guide system through landmarks such as tibial tubercle, tibial spine and ankle joint. Due to obesity, skeletal dysplasia or joint deformities, the conventional extramedullary cutting guide system has disadvantages such as difficulty in placement, positioning errors, hindering operation and prolonging operation time [6]. In addition, most cutting blocks cannot be adjusted individually due to the fixed PSA.

We report a surgical technique for tibia bone cutting block without positioning rods (Fig. 1) in TKA. As far as we know, there is no relevant literature report.

Methods

Case Presentation and Surgical Technique

A 67-year-old male was hospitalized with left knee joint pain for more than 4 months. Ten years ago, the patient had a history of surgery for left lateral tibial plateau fractures. The physical examination showed tenderness in the medial side of the left knee, range of motion (ROM) 5˚-95˚, visual analogue scale (VAS) was 6, internal rotation squeeze test (+). Before the operation, taking the anteroposterior, lateral and full-length X-ray of the knee in the standing position. Measure the mechanical axis (MA) of the lower limbs, PSA and the thickness of tibia bone cutting by X-rays (Fig. 2).

A median incision was made in the knee joint with a parapatellar approach. Completing the valgus bone cutting by intramedullary guide rod in femoral side. Using the “four in one” bone cutting block to complete the distal femoral bone cutting. The tibia bone cutting block with guide rod is placed in front of the proximal tibia. Fixing the PSA reference plate to the medial tibial platform. Placing the PSA positioning plate naturally on the medial tibial platform and fix it, which represents the physiological PSA. The PSA positioning plate was inserted into the first channel of the tibial cutting block. When the physiological PSA was 0°-10 °, the cutting block was placed normally. If the PSA was greater than 10°, the PSA of the block would be adjusted to 10° [7]. Fix the inner "0" fixing hole of the cutting block. The metal probe was placed on the central bone surface of the lateral tibia plateau. The lateral tibial cutting thickness was determined by the height of the metal probe and the lateral column of the block (8mm). The cutting block was fixed, and the surgeon completed the proximal tibial bone cutting through the second channel in the cutting block (Fig. 3). The joint gap balance was completed, and the cemented femoral-tibial prosthesis was installed. The skin was sutured layer by layer.

Results

On the second day after the operation, the patient underwent routine rehabilitation training. The post-operative positive, lateral and the full-length X-ray were taken after one week. The ROM was 0°-110° and the VAS was 2 at the last follow-up. (Fig. 4).

Discussion

Tibial bone cutting has a significant effect on the balance of soft tissues and gaps in TKA. Accurate bone cutting is related to the efficacy of TKA and the survival rate of the prosthesis [8]. The surgeon needs to determine the PSA and the cutting thickness to complete the positioning of the bone before tibia cutting.

The physiological PSA is generally 0°-10°. With the help of different reference methods, the surgeon can plan the bone cutting thickness and individualized PSA on the preoperative X-ray [9]. Clinically, intramedullary, extramedullary positioning methods or a combined technology are used. Some doctors even complete the bone cutting without any guide. In extramedullary positioning, the surgeon determines the PSA by adjusting the distance between the guide rod and the anterior tibial skin, which is prone to errors. Iorio et al. [10] believe that the traditional extramedullary guide system can easily lead to a smaller

PSA. For patients with tibial rotation deformity, the extramedullary guide rod cannot even achieve positioning. Intramedullary guide system also has certain shortcomings [11, 12]. The computer navigation system can improve the accuracy and precision of bone cutting. But it is limited by high price, long learning cycle and inability to be widely popularized [13].

Through the self-designed proximal tibial cutting block and technology without guide rod, we can quickly place the bone cutting block. The individualized PSA can be determined quickly through the PSA reference plate. According to repeated attempts, we set the distance between the two through-slots to 5mm. This distance can ensure that the bone cutting thickness at the edge of the medial tibial plateau is about 2 mm (Fig. 5).

Our technology has the following advantages: 1. No need for guide rod, simplifying the operation and shortening the TKA learning cycle; 2. Quickly determining the individualized PSA and bone cutting thickness, and shortening the operation time; 3. Suitable for all TKA patients, especially those with tibial rotation deformity. But, the patients with severe bone defects cannot use it, which is its limitation.

Conclusion

The tibia bone cutting block without guide rod can simplify the TKA process, improve the accuracy of tibia bone cutting and post-operative MA of the lower limb.

Abbreviations

TKA: Total knee arthroplasty

KOA: Knee osteoarthritis

PSA: Posterior slope angle

ROM: Range of motion

VAS: Visual analogue scale

MA: Mechanical axis

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University (Zhejiang Provincial Hospital of Chinese Medicine), number:2019-X-038-01.

Consent for publication

All the authors approved the manuscript.

Availability of data and materials

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

Competing interests

The authors declare they have no competing interests.

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Authors' contributions

Author CXB was the primary surgeon, who conceptualised the study and developed the protocols and was a major contributor for the study. Author LSJ was primarily helpful in the statistical analysis. Authors CXB and LSJ helped in writing and reviewing the manuscript. All authors have contributed to the write up and read and approved the final manuscript.

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Not applicable.

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Figures

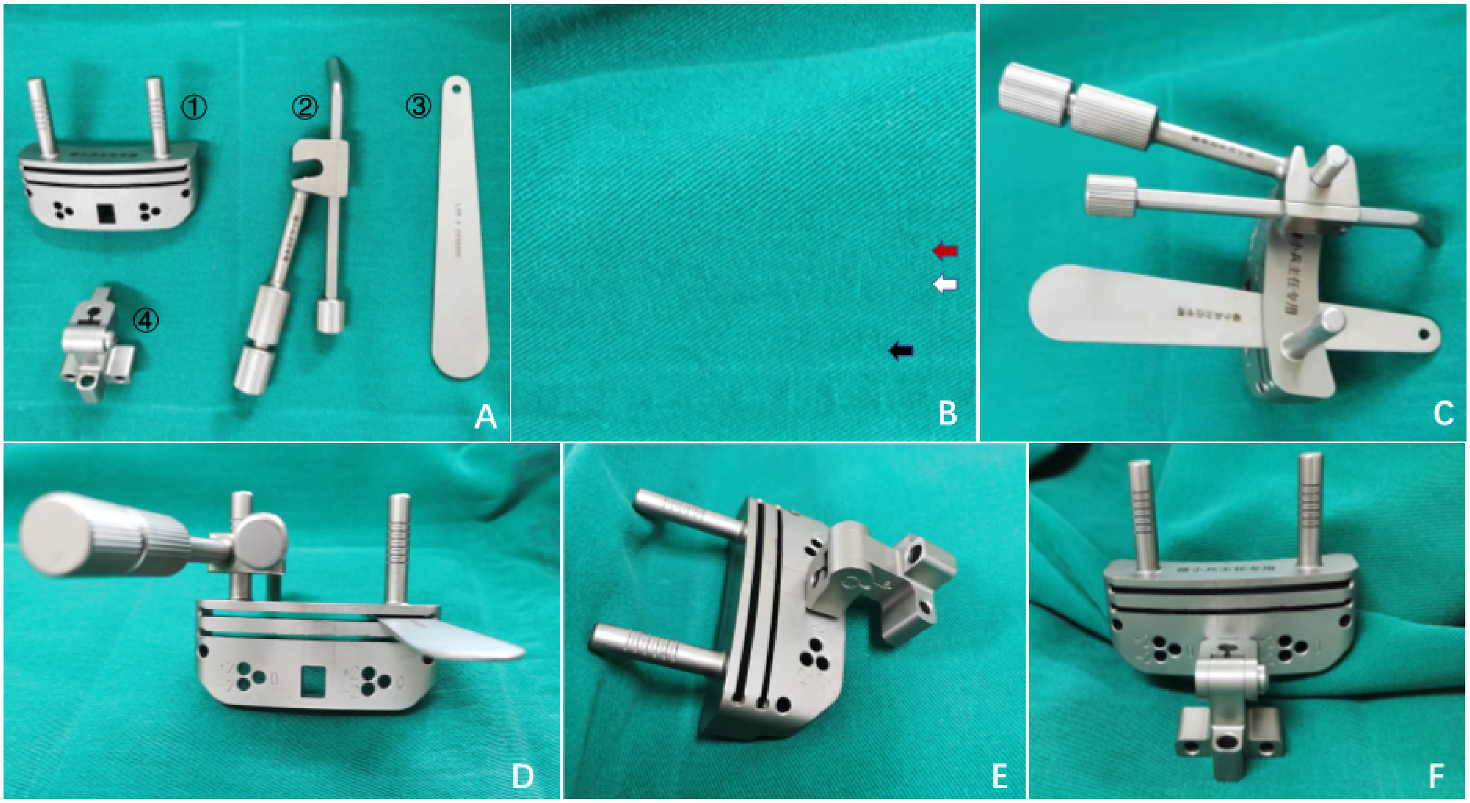

Figure 1

A. Tibia bone cutting block without positioning rods:① bone cutting block, ② Metal probe, ③ Posterior slope angle positioning plate, ④ Force line calibrator;B. Tibia bone cutting block: the first channel (red arrow) , the second channel (white arrow) and the fixing hole (black arrow); C. Top view of the tibia bone cutting block without positioning rods; D. Front view of the tibia bone cutting block without positioning rods; E. Top view of the tibia bone cutting block with force line calibrator; F. Front view of the tibia bone cutting block with force line calibrator.

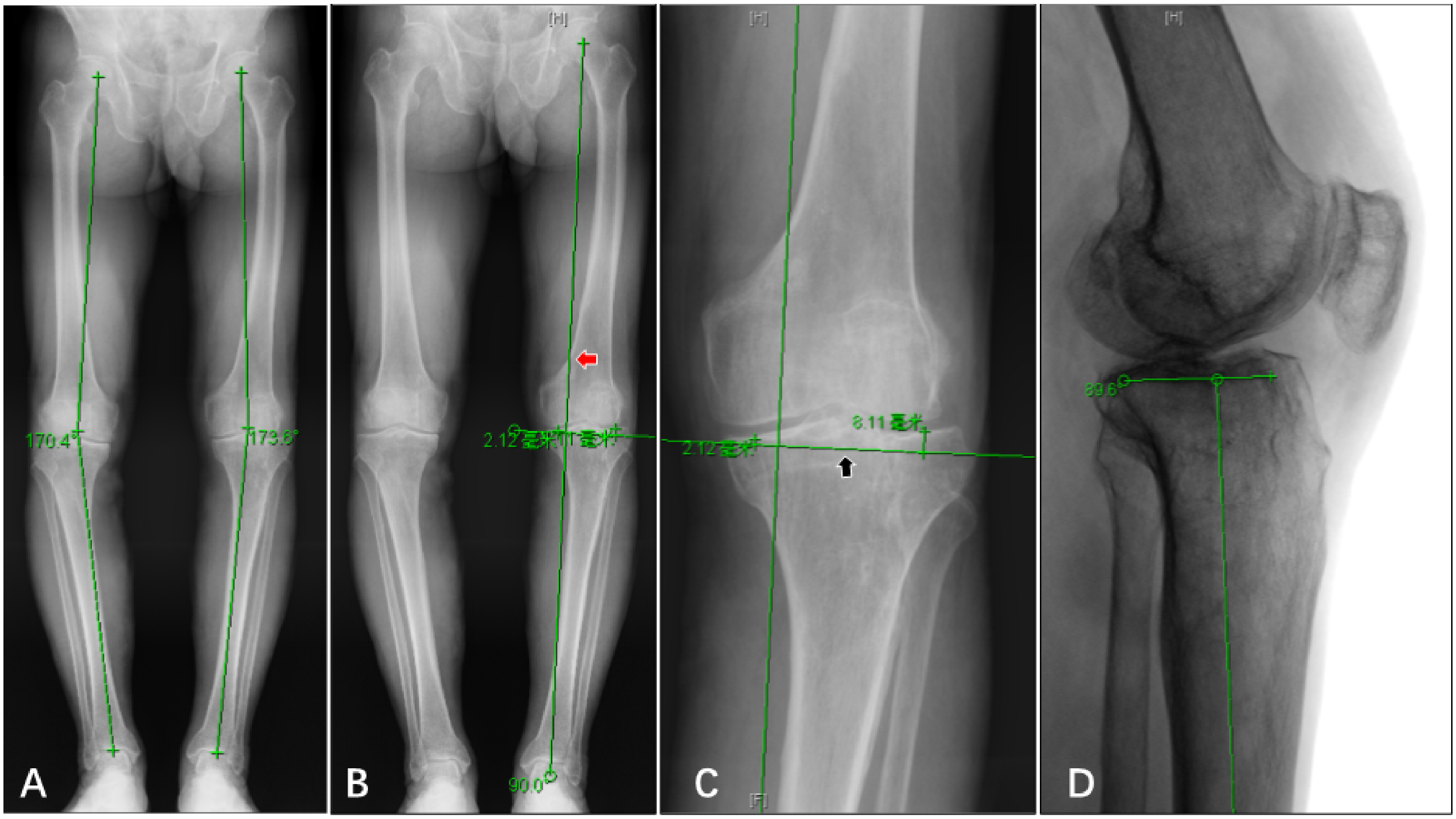

Figure 2

A. Preoperative mechanical axis of the left lower limbs was 173.6˚; B-C. Draw the expected mechanical axis (red arrow) along the center of the femoral head and ankle joint. Draw a line (tibia bone cutting line, black arrow) perpendicular to the expected mechanical axis on the proximal tibia. Taking the bone cutting thickness at the center of the medial tibial plateau of 2 mm as a reference, the planned bone cutting thickness of the lateral platform was 8 mm; D. The posterior slope angle was 0.4˚.

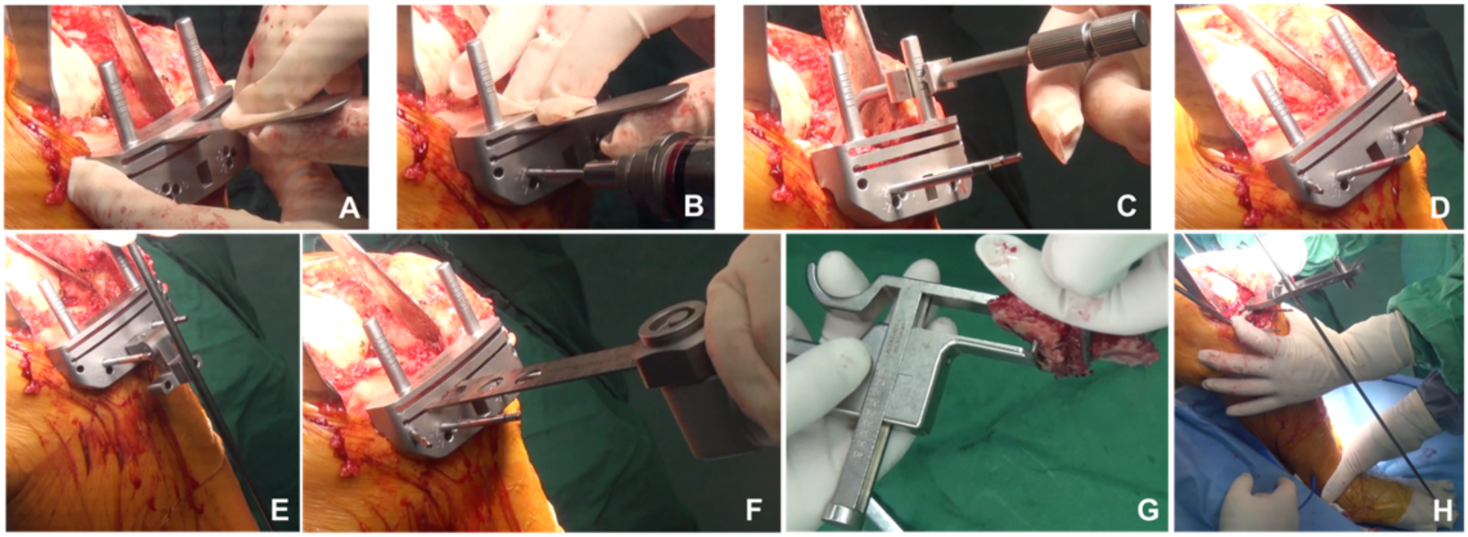

Figure 3

A. Placing the posterior slope angle positioning plate naturally on the medial tibial platform through the first channel of the tibial cutting block; B. Fix the inner "0" positioning hole of the cutting block; C. Placing the metal probe on the central bone surface of the lateral tibia plateau; D. Fix the bone cutting block; E. Confirm the mechanical axis of the lower limbs by force line calibrator; F. Bone cutting through the second channel of the tibial cutting block; G. Measure the bone thickness; H. Confirm the mechanical axis of the lower limbs again.

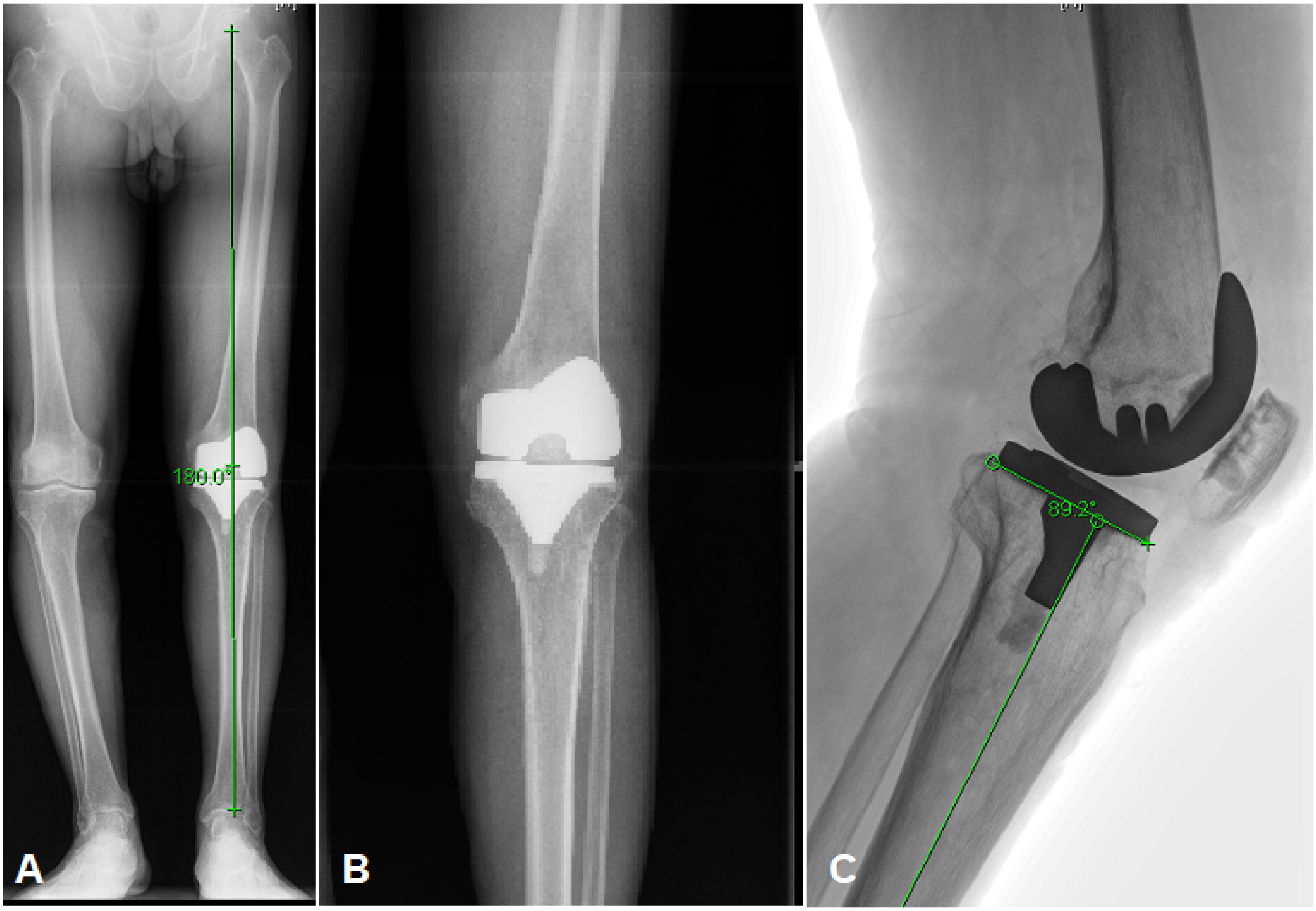

Figure 4

A. Postoperative mechanical axis of the left lower limbs was 180˚; B-C. The anteroposterior and lateral postoperative X-ray. The posterior slope angle was 0.8˚.

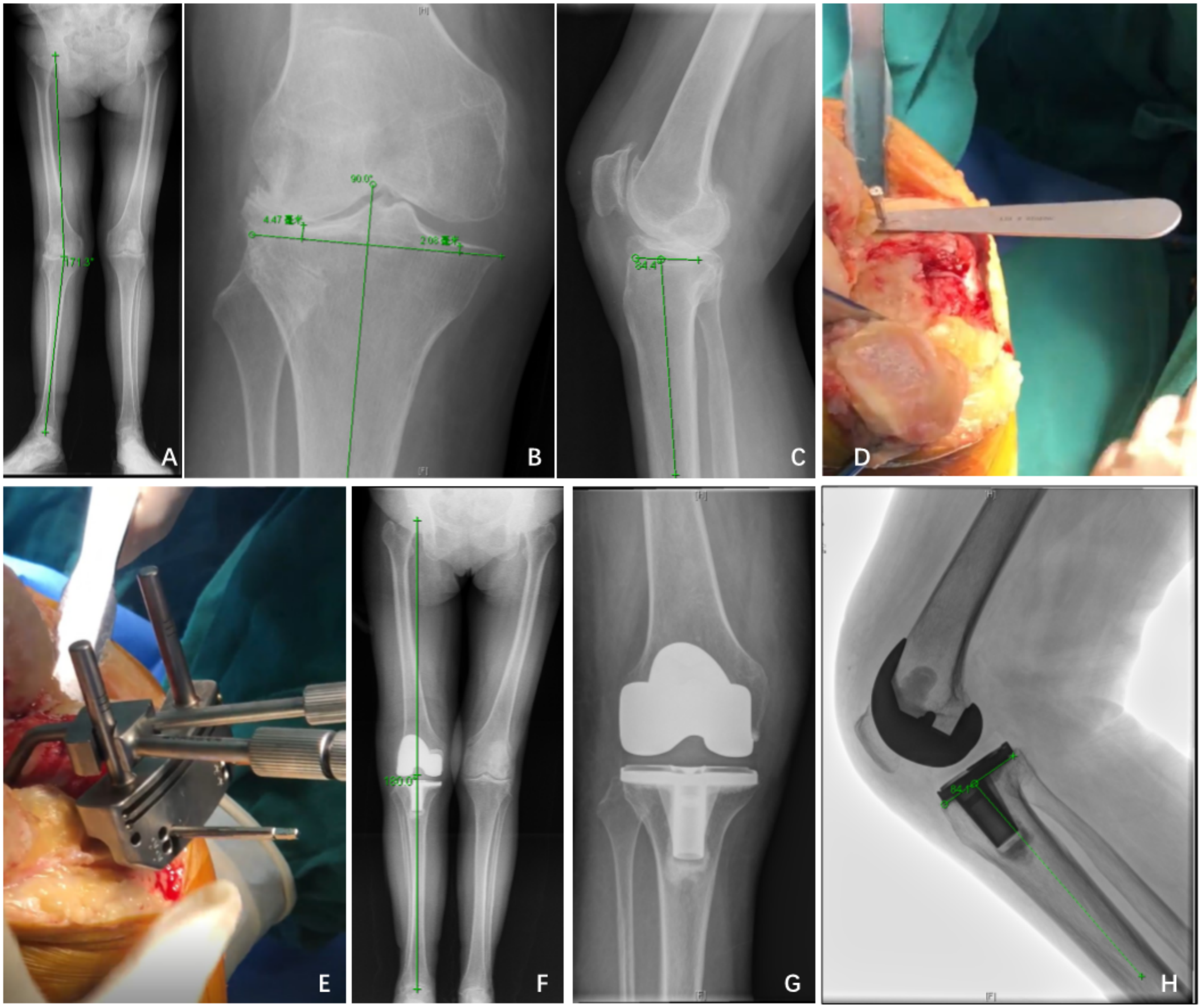

Figure 5

A 72-year-old female patient was admitted to the hospital because of right knee pain for 10 years and aggravation for 1 month. Physical examination showed pain in the medial side of the right knee, patella grinding test (+) A. Preoperative mechanical axis of the right lower limbs was 171.3˚ (vaglus); B. Taking the bone cutting thickness at the center of the medial tibial plateau of 2 mm as a reference, the lateral bone cutting thickness was 4 mm; C. The preoperative posterior slope angle was 5.6˚; D. Placing the posterior slope angle positioning plate naturally on the medial tibial platform; E. Placing the metal probe on the central bone surface of the lateral tibia plateau and fixing the bone cutting block; F. The postoperative mechanical axis of the right lower limbs was 180˚; G-H. The postoperative positive and lateral X-ray. The posterior slope angle was 5.9 ˚.

Supplementary Files