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Reliability of two techniques and training level of the observer in measuring the correction angle when planning a high tibial osteotomy

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ABSTRACT

Background: In high tibial osteotomy, planning is critical for achieving successful realignment. Any method selected needs to be reliable, with inter-observer and intra-observer correlation. A literature review demonstrated two distinct methods of planning for high tibial osteotomy.
Hypothesis: Both methods are precise and show excellent inter and intra-observer correlation.
Method: Fifty consecutive weight-bearing long leg alignment antero-posterior (AP) radiographs were identified and planning undertaken on suitable radiographs using the methods of Puddu (method 1) and Miniaci (method 2). Two observers, one junior trainee and one Specialist Knee Fellow, recorded measurements to calculate inter and intra-observer correlation.
Results: Thirty-two radiographs were included. Inter-observer and intra-observer correlation, and correlation between the two methods were all greater than 0.97 ($p < 0.0001$).
Conclusion: Our results show excellent correlation between both methods and both observers. Both methods are reliable for planning and can be performed by both junior trainees and sub-specialists. Further work should consider how planning can ensure adequate intraoperative correction.

1. Introduction

High tibial osteotomy (HTO) has become an accepted technique for management of medial osteoarthritis in young patients with proximal tibial varus [1]. The procedure allows the weight-bearing axis to be moved in a controlled manner to achieve a variable degree of offloading towards or into the lateral compartment of the knee. Severity of symptoms is reduced but there is also published evidence that the area of cartilage wear is repaired [2]. The osteotomy may be performed with a closing wedge, opening wedge, barrel-vault, or dome procedure [3]. Favourable results have been achieved with all these methods [1,4,5] although the use of medial opening wedge techniques avoid the potential problems of the closing wedge technique, including risk of peroneal nerve damage, tibial shortening and offset, damage to extensor muscles, need for fibular osteotomy, and potential compromise to future total knee arthroplasty [1,6–8]. Medial opening wedge techniques, which avoid these complications, were previously limited by the morbidity associated with the need for bone graft, but stable locking plate implants that negate this have produced good results [6].

When undertaking a high tibial osteotomy, planning is critical for achieving successful realignment [9–12]. An evaluation of 54 knees with arthroscopy after valgus high tibial osteotomy for osteoarthritis concluded that the ideal correction aligns the mechanical axis to pass through a point 30–40% lateral to the midpoint of the tibial plateau [2]. This equates to 65–70% of the width

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of the whole tibial plateau measured from medial to lateral. Any method selected needs to be reliable, with consistency between different users and the same user on different occasions.

Since the first descriptions of high tibial osteotomy techniques occurred before the advent of picture archiving and communication systems (PACS), most original planning involved templates or moving transparent paper over plain radiographs [3,4,12]. More recent studies have shown that manual measurements from plain radiographs and PACS or software packages for making computer-assisted measurements from digitised images are all reliable methods of measurement [13–18].

CT scanograms have been used to measure lower limb mechanical axis as they expose patients to less radiation. However, a study from our group showed a greater proportion of cases with malalignment more than five degrees were identified with weight-bearing full-length radiographs compared to CT scanograms [19]. As knee alignment is vital for planning in high tibial osteotomy, weight-bearing long leg alignment antero-posterior (AP) radiographs are used.

A literature review revealed just two distinct methods of planning for high tibial osteotomy that correspond to two of the implants available. The first method is described by Puddu [20] and the second method is described by Miniaci [4]. These are demonstrated in Figure 1.

We had two hypotheses. Firstly, we proposed that there would be no difference in measurements between the two methods and secondly, that there would be excellent intra-observer or inter-observer correlation.

2. Patients and methods

A list of 50 consecutive weight-bearing long leg alignment antero-posterior (AP) radiographs extending from the hip to the ankle was generated by our Radiology department. These radiographs may have been performed a variety of different indications. Those radiographs that had evidence of genu varum suitable for proximal tibial osteotomy were identified. Radiographs with normal alignment or genu valgum were excluded.

Planning was then undertaken on each of the suitable radiographs using the two methods described. Two observers performed the measurements; one junior core surgical trainee and one Knee Fellow with seven years of higher surgical training including 24 months of subspecialty experience in knee surgery. The radiographs were measured independently by each observer using both measurement techniques (inter-observer variability) and then all measurements repeated two weeks later by each observer (intra-observer variability).

In the first method, Puddu [20] draws a line from the centre of the femoral head through a point 62.5% of the width of the proximal tibia measured from the medial side. Another line is drawn from the centre of the ankle joint to this point. The angle made by these two lines is the degree of correction required.

The second method from AO International [10] describes a modification of Miniaci's closing wedge technique [4] for the locking compression plate (Tomofix, Synthes). The weight-bearing line is drawn from the centre of the femoral head to the centre of the ankle joint. The desired mechanical axis is drawn from the centre of the femoral head through a point 30–40% of the width of the lateral tibial plateau from the midline and extended to a point level with the talar dome. The opening angle is determined by defining the hinge for the osteotomy at a point-five-millimetre medial to the tibial cortex at the level of the tip of the fibula.

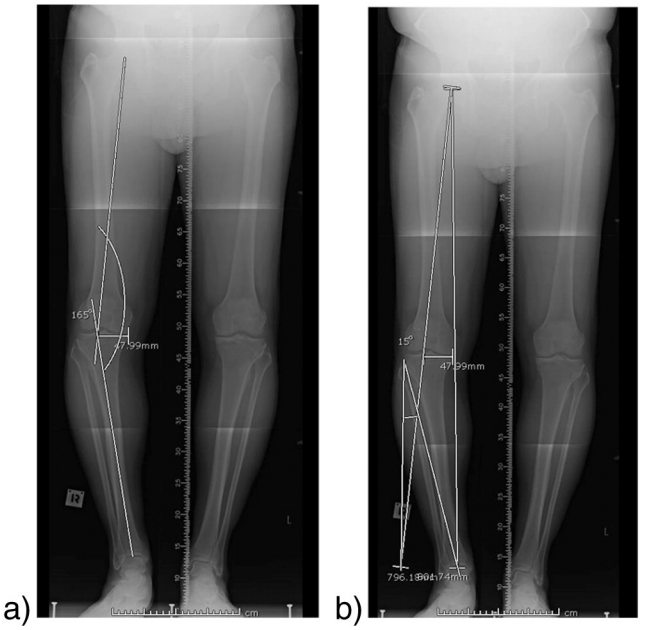

Figure 1. Long leg alignment radiographs with osteotomy planning lines for a) Method 1 - the Puddu method and b) Method 2 - the Miniaci method showing the same desired correction angle.

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