

Relevance of Asymmetric Extension Gap on Initial Post-Operative and Weight-Bearing X-Rays After Total Knee Replacement

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ABSTRACT

INTRODUCTION: Asymmetric gap between the femoral and tibial component after primary total knee replacement (TKR) is a known cause of post-operative pain. This study investigates whether significant asymmetric extension gaps seen on initial post-operative non-weight-bearing (NWB) radiographs persist on follow-up weight-bearing (WB) radiographs.

METHOD: 203 consecutive patients who underwent primary TKR, and had adequate radiographic follow-up during a four-year period, were included. The distance between the tibial tray and femoral condyle on the medial and lateral sides was measured on initial NWB

and follow-up WB radiographs, to identify significant asymmetric extension gaps. Previous studies showed medial extension gaps of ≥ 1.5 mm may be associated with increased pain post-operatively. Therefore, we defined a significant gap as ≥ 1.5 mm. The results were examined to determine whether initial post-operative gaps remain appreciable on follow-up x-rays.

RESULTS: Of the 203 radiographs reviewed, 29 (14.3%) patients had an extension gap mismatch of ≥ 1.5 mm on initial post-operative imaging. 13 (44.8%) patients had a medial opening gap whilst 16 (55.2%) had a lateral opening. Only 4 (13.8%) of these patients showed no significant change in the asymmetrical extension gap (remained ≥ 1.5 mm) on WB x-rays. In the remaining patients, the gap was no longer appreciable.

CONCLUSION: The study showed that if patients present with post-TKR pain, which could be related to a medial opening extension gap, clinicians should use initial NWB x-rays to investigate as the gap mismatch may not be detectable on follow-up WB radiographs.

Key Words: Total knee arthroplasty; Total knee replacement; Knee revision; Knee radiographs; Revision surgery

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INTRODUCTION

261,842 primary total knee replacements (TKR) were carried out in the UK between January 2014 and December 2016^[1]. However, up to 20% of patients may experience pain post-operatively despite satisfactory radiological appearance of the TKR components^[2]. The aetiology of post-operative pain after knee replacement is multifactorial. Inadequate ligament balancing leading to an asymmetric gap between the femoral and tibial component following primary TKR may be a possible cause for persistent post-operative pain. A study investigating the relationship between asymmetric extension gaps and post-TKR pain showed that a

medial extension gap of ≥ 1.5 mm is associated with increased post-operative pain^[3].

In most orthopaedic centres, anteroposterior (AP) knee radiographs are obtained in a non-weight bearing (NWB) position in the immediate post-operative period, but all subsequent AP radiographs are obtained in a weight bearing (WB) position.

The aim of the study is to determine whether the imbalance should be diagnosed on the initial NWB radiographs or the follow-up radiographs, which are usually performed in a WB position. For this purpose, we investigated whether a significant asymmetric extension gap seen on initial NWB post-operative radiographs following primary TKR is consistently present on follow-up WB radiographs.

METHOD

The study was registered as a service evaluation project with our hospital and was a retrospective analysis of radiographs.

We identified 238 consecutive patients in a single surgeon series who underwent a primary TKR during a four-year period (2010 to 2014). Out of these, 203 had adequate radiographic follow-up. The prosthesis included primary knee replacement implants made by three different implant companies. No distinction was made on the basis of the manufacturer as principles of balancing of the knee are universally applicable. The surgical technique was measured resection for all patients. The exclusion criteria were inadequate radiographic follow-up, the use of semi-constrained or hinged implants, and poor quality of the initial radiograph leading to inability to measure the extension gap. The cause of suboptimal initial radiograph was usually due to improper positioning and/or patient not being able to fully extend the joint at that stage.

The initial postoperative radiograph was done in the supine, non weight bearing position and the follow up radiographs were done in the weight bearing position. We did not use fluoroscopy guided positioning of the radiograph as this is not routine practice in most hospitals in our health care system. The beam was centred on the knee at the level of the tibial tray. The 203 selected radiographs were then examined, on IMPAX (x-ray viewer), by measuring the minimum distance between the tibial tray and femoral condyle on the medial and lateral sides, on both the initial and WB radiographs (Figure 1). The prime parameter observed was any significant asymmetry in the extension gap on either radiograph. The radiographic measurement is demonstrated in Figure 2A and 2B.

We defined significant extension gap asymmetry as ≥ 1.5 mm based on existing literature^[3].

RESULTS

Of the 203 radiographs reviewed, 34 (16.7%) patients were found to have an extension gap mismatch on imaging. 29 (14.3%) patients were found to have an extension gap mismatch of ≥ 1.5 mm on initial NWB post-operative imaging, whilst 9 (4.4%) patients had a mismatch ≥ 1.5 mm on follow-up WB radiographs. 4 patients had a gap mismatch on both initial and follow up imaging and were included in both groups.

Of the 29 patients with a mismatch on initial imaging 13 (44.8%) had a medial opening extension gap, whilst 16 (55.2%) had a lateral opening.

Only 4 (13.8%) of the patients with an extension gap on initial NWB images showed persistence of asymmetrical extension gap (it remained ≥ 1.5 mm) on WB x-rays. In the 25 remaining patients (86.2%), the gap was no longer appreciable on the follow-up WB x-rays.

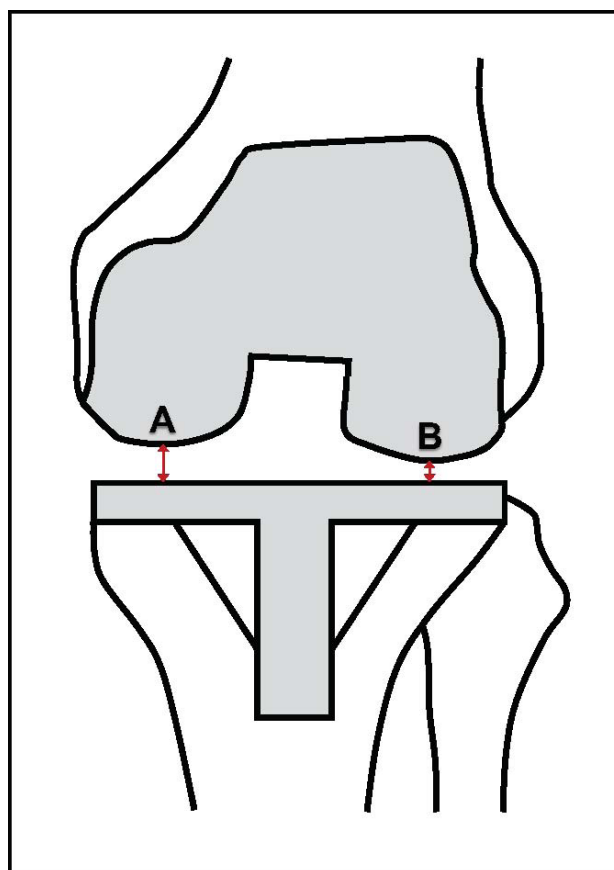


Figure 1 Schematic diagram of the points measured on each radiograph. A - Medial condyle of femoral component to tibial tray; B - Lateral condyle of femoral component to tibial tray. Adapted from Liebs et al^[3].

DISCUSSION

Accurate ligament balancing is one of the tenets of knee replacement surgery. The techniques for intra-operative gap balancing have been described in detail in literature. ‘Femoral condylar lift off’ is asymmetry of the femoro-tibial gap in deep knee flexion and may be associated with eccentric loading and early loosening of the prosthesis^[4].

Infection, instability and loosening are the most common prosthesis related causes of painful total knee replacement^[5]. While infection and loosening can be diagnosed with a high predictive value, diagnosis of instability is more subjective^[6]. Inadequate balancing is more common than usually appreciated and may be associated with post-operative pain^[7].

Medial instability correlates more closely with persistent pain after total knee replacement^[8]. The parameters for acceptable degree of instability remain undefined. Moreover, the normal range of acceptable post-operative instability may vary between patients.

Gross malalignment will lead to eccentric loading of the implant and the consequent stress at the fixation interface can lead to early loosening and failure of the implant. Gross malalignment and instability will be accentuated on weight bearing, and hence the practice of utilising weight bearing radiographs. However, we believe subtle coronal plane laxity may be obscured by weight bearing radiographs.

Liebs demonstrated that an asymmetric extension gap seen on routine post-operative x-rays is common, and that a threshold for this gap in association with pain (measured by WOMAC pain score) can be identified^[3]. The strength of the association of an asymmetrical

extension gap with the pain score was noted to decrease over the initial 12-month post-operative period. This could be due to stretching of tissues over time, and increased muscle strength leading to a reduction in the asymmetrical gap. However, the study did not determine whether the extent of the asymmetric gap seen on immediate post-operative x-rays remains the same on follow-up imaging.

The limitations of this study include its retrospective nature, and the lack of comparative data from similar studies. Excluding inadequate radiographs has helped to remove some of the possible inaccuracies. However, we feel that this study addresses the conundrums faced by the practicing orthopaedic surgeon when evaluating patients with painful knee replacements and asymmetric gaps. Fluoroscopic guided comparable radiographs would help to improve the quality of the data, although these are impractical in the vast majority of orthopaedic departments for routine follow up evaluation of knee replacements. Persistence of asymmetric gap on radiographs remains unknown at present. It is possible that NWB or WB would influence the gaps seen on radiographs. In our study, 86.2% patients did not have a significant gap on follow up radiographs. The most likely explanation for this is the difference of method of obtaining radiographs. Spontaneous resolution of laxity is a possibility, albeit very unlikely. Further studies would be helpful to determine the natural course of laxity.

Another limitation is the lack of correlation with intra-operative data on gap balancing. The use of robotic and computer aided systems allow dynamic record of intraoperative flexion and extension gaps. However, these systems are not widely used at present and the majority of knee replacements are carried out using manual jigs and surgeon dependant gap balancing.

The presence and persistence of asymmetric gap on radiographs is poorly understood, with little data existing in literature. Our study showed that only 13.8% of the asymmetrical extension gaps identified on initial NWB images remained on follow-up WB radiographs which, may be due to the reasons discussed above. This has potential clinical implications if a patient is being investigated for post-TKR pain; if clinicians use follow-up WB radiographs to detect a medial opening gap it may no longer be appreciable. Therefore, it may be missed as a potential cause for persisting post-operative pain.

CONCLUSION

The study showed that if patients' present with post-operative pain following knee replacement surgery, that could be related to a medial opening extension gap, clinicians should use the initial NWB x-rays to investigate this as the gap may not be detectable on follow-up WB radiographs.

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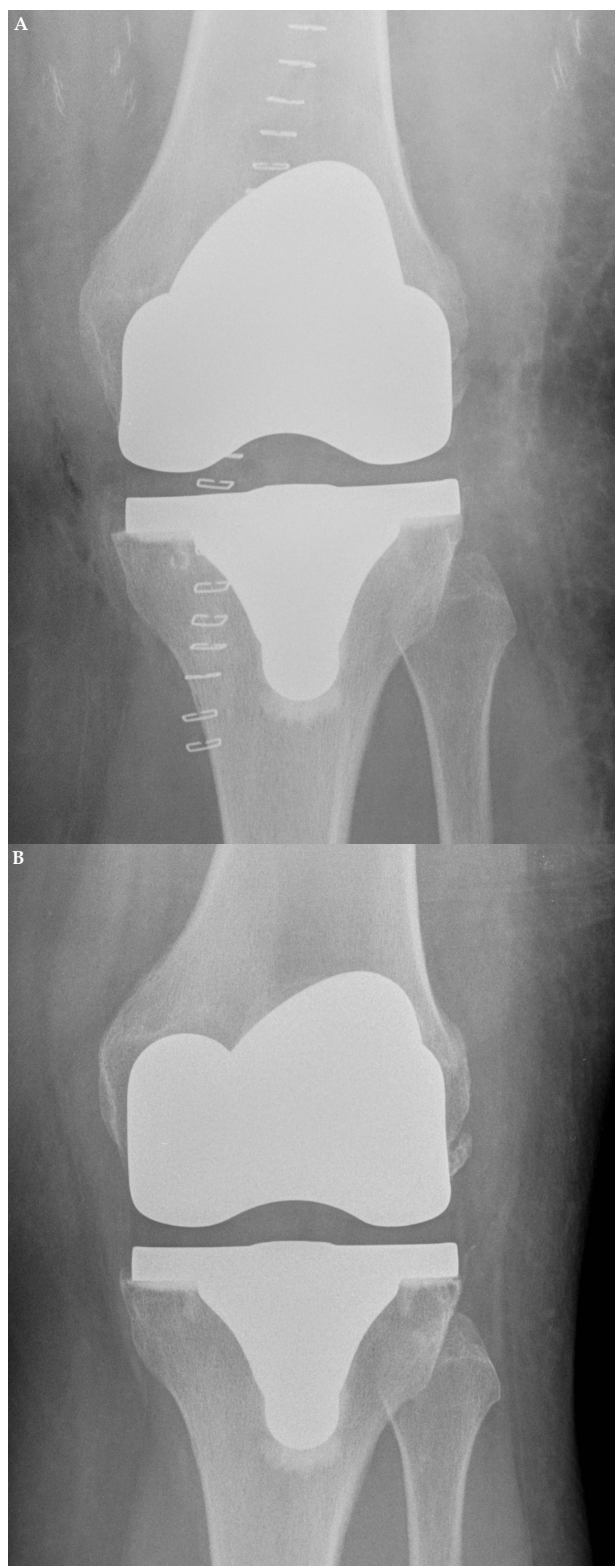


Figure 2 A: Non-weight bearing AP radiograph showing widened gap between the medial femoral condyle and medial tibial margin compared to the lateral side. B: Weight bearing, follow up AP radiograph of the same patient showing equalization of the medial and lateral gap.

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