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DISTANCE BETWEEN TIP OF FIBULAR HEAD TO TIBIAL TUBEROSITY: THE ALTERNATIVE BONY LANDMARK TO DEFINE MAXIMUM PROXIMAL TIBIAL CUT AND JOINT LINE LEVEL DURING TOTAL KNEE REPLACEMENT (TKR)

JARAK ANTARA FIBULAR HEAD DENGAN TUBEROSITAS TIBIA : ALTERNATIF BATAS TULANG UNTUK MENENTUKAN JARAK MAKSIMUM POTONGAN PROXIMAL TIBIA DARI SENDI LUTUT DALAM OPERASI PENGGANTIAN SENDI LUTUT

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ABSTRAK

Prosedur penggantian sendi lutut telah banyak dilakukan untuk merawat pasien dengan kelainan anatomi yang berat disertai keterbaasan fungsi lutut. Saat melaksanakan reseksi tibia proksimal, ahli bedah harus menghindari pemotongan tulang yang tidak perlu. Oleh karena itu batasan reseksi pada tibia proksimal perlu dipastikan untuk mengembalikan garis sendi dan tidak melewati tepi atas fibula untuk menghindari lesi saraf perineal. Tujuan dari penelitian ini untuk mempelajari jarak rata-rata antara tuberositas tibia dan tepi atas fibula. Jarak tersebut dapat digunakan sebagai pedoman kasar bagi ahli bedah untuk menentukan tingkat maksimum pemotongan tibialis proksimal dari garis sendi. Penelitian ini mengukur jarak antara tepi atas fibula ke tuberositas tibia dari foto polos lateral lutut. Pengukuran dilakukan terhadap radiografi lateral lutut semua pasien yang menjalani operasi artroplasti lutut total di RS X Surakarta periode Januari 2018 - Januari 2019. Pengukuran menggunakan software Horos. Penelitian ini menggunakan 200 sampel, 151 wanita dan 49 pria. Jarak rata-rata keseluruhan antara ujung kepala fibula dan tuberositas tibia adalah 18,57 mm; 19,37 mm pada wanita dan18,31 mm pada pria. Tidak ada perbedaan yang signifikan antara pasien pria dan wanita. Kami merekomendasikan jarak 18,57 mm dari tuberositas tibia sebagai batas reseksi maksimum pada pemotongan tibialis proksimal selama TKR. Jarak ini juga dapat digunakan sebagai pedoman kasar untuk menentukan tingkat garis sendi dengan menambahkan 10 mm pada jarak tersebut.

***Kata kunci**: Tuberositas Tibia, Reseksi Tibia, Batas Garis Sendi, Penggantian Sendi Lutut Total*

ABSTRACT

Total knee replacement (TKR) procedure has been widely performed to treat patients with severe deformity and limited knee function. During resection of the proximal tibia, the surgeon has to avoid unnecessary bone loss. Therefore the resection limitation on the proximal tibia needs to be confirmed to restore the native joint line and not to more distal than the tip of the fibular head to avoid peroneal nerve lesion. The purpose of this work is to study the average distance between the tuberosity of the tibia and the tip of the head of the fibula. The distance can be used as a rough guide for the surgeon to define the maximum level of proximal tibial cut and the level of the native joint line.

This study measures the distance between the tip of the fibula head to the tibial tuberosity from the lateral plain radiograph of the knee. The measurement was performed to the lateral radiograph of the knee of all patients (200 knees) who received total knee arthroplasty surgery at X Hospital, Surakarta from January 2018 – January 2019. Horos software was used for measurement. There were 200 samples, 151 female and 49 male patients. The overall average distance between the tip of the fibular head and tibial tuberosity is 18,57 mm; 19,37 mm in female and 18.31 mmin male. There was no significant difference between male and female patients. We recommend the distance of 18,57 mm from tibial tuberosity as the maximum resection limit in proximal tibial cutting during TKR. This distance also could be used as a rough guide to defining a level of the joint line by adding 10 mm to it.

***Keywords**: Tibial Tuberosity, Tibial Resection, Joint Line Level, Total Knee Replacement*

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INTRODUCTION

Arthroplasty research for hip or knee replacement advance in the 1950s, after it's first introduced in the late 19th century (Gomez and Morcuende, 2005). Extended research is being held to develop the surgical technique of this surgery (Moore and Bohlman, 1983; Shiers, 1954). It is one of the orthopaedic subspecialties that aims to restore function joints of the musculoskeletal system, including large joints of the hip, knee (Holzer and Holzer, 2014). Studies show 25% to 30% of patient underwent TKR have alignment outside its preferred range, it is believed that implant malalignment leads to altered biomechanical forces and increased implant wear and failure (Nankivell *et al*., 2015).

Accurate measurement of tibial resection developed from computer navigation (Nankivell *et al*., 2015) to robot-assisted surgery have been studied(Dalury and Aram, 2016). Studies using those methods were found to be reliable and reduce the risk of bone over resection in TKR. But it is nonapplicable in developing countries with limited resources. On the other hand, the fibular head as a landmark is the commonly used indicator for joint line level, especially during revision TKA surgery (Sadaka *et al.*, 2015). However, it is sometimes difficult to define a level of fibular head intraoperatively, especially in an obese patient (Fig. 1). Therefore simple guidance needs to be developed for the determination of the maximum level in tibial resection and a rough guide to defining the level of the joint line. We hope the outcomes of our research provide excision limitation of tibiofemoral surface in TKR procedure.

Figure 1. Intraoperative image during TKR. A. An easily identified and palpable tibial tuberosity, B. Tip of head fibula covered by fat tissue, sometimes it is difficult to define.

METHODS

This is a descriptive study of bonny landmarks in TKR procedure. Data was taken from the Radiology Department of Prof. Dr. Soeharso Orthopaedic Hospital database from January 2018 to January 2019. True size knee lateral plain radiograph was used and measured using the ruler function on Horos software an open-source DICOM viewer.

The measurement was started by making a vertical line from the tip of the head fibula through the fibular shaft (Fig. 2). This vertical

line is aligned with an anatomical axis of the tibia. It was drawn by firstly drawing an anterior cortical line of the tibia and posterior cortical line of tibia, and then make a line as a tibial anatomical axis between those two lines. Two horizontal lines were made perpendicular to the vertical line. The first horizontal line was pulled from the vertical line to the tibial tuberosity, and the second horizontal line was made from the tip of the head fibula, aligned with the first horizontal line. The height difference between the tip of the head fibula and the tuberosity tibia was obtained by measuring the distance between those two horizontal lines. Radiograph sampling was taken from an osteoarthritic patient with an age range from 40 to 80-year-old who planning for TKR surgery.

Figure 2. Measurement of distance from the tuberosity of the tibia to the tip of the head fibula. A= Tibial anatomical axis; B= Vertical line from the tip of head fibula through the fibular shaft; C= Horizontal line from Tuberosity of Tibia (TT) to Line B, perpendicular with line A; D= The horizontal line from Head of Fibula (HF), aligns with line C, perpendicular with line A. E= Distance from TT to HF, the distance between line C and D. The measurement were taken using the ruler function in Horos application.

RESULT AND DISCUSSION

There was a total of 200 knees (49 male, 151 female) radiograph included in the study. In the male patient, the maximum distance was 27,64 mm with a minimum of 11,16 mm with a mean of 19,37 mm. While in female patients the maximum distance was 25,95 and the minimum distance was 11,03 mm with a mean of 18,31 mm. We obtain an overall 18,57 mm as the mean distance from tibial tuberosity to the tip of the fibular head (Table 1).

Table 1. Subject Characteristic and Result of The Tibial Tuberosity to The Tip Of Fibular Head Distance Measurement

Characteristic	Gender		Mean
	Male	Female	
Number (%)	49 (24,50)	151 (75,50)	
Age (Years)			60
▪ **Youngest**	42	43	
▪ **Oldest**	73	77	
▪ **Mean**	61	60	
TT to HF Distance (mm)			18,57
▪ **maximum**	27,64	25,95	
▪ **minimum**	11,16	11,03	
▪ **mean**	19,37	18,31	

**TT= Tuberosity of Tibia, HF= Head of Fibula*

Tibial tuberosity is an oval elevation on the anterior surface of the tibia about 3 cm distal to the articular surface, giving attachment at its distal part to the patellar ligament (*Farlex Partner Medical Dictionary*, 2012). In recent decades many studies have been done to improve implantation techniques of TKR. The

improvement of knowledge in TKR allows surgeons to use a better and updated procedure. However, only a few studies discussed bone resection limits in TKR procedures (Nessler, 2010). Plain radiograph might give an alternative option for tibial resection guidance in preoperative planning on TKR. The surgeon could determine the maximum level of proximal tibial cut by measuring the distance between tibial tuberosity and tip of fibular head on a preoperative lateral knee radiograph. The tip of the fibular head is commonly used as a maximum level of the proximal tibial cut. We prefer to use a lateral knee plain image rather than anteroposterior radiograph. As it is easier indetify tibial tuberosity on lateral radiograph by determine the highest eminence of the tuberosity . We could not define the highest eminence of tuberosity on anteroposterior radiograph.

Regarding the joint line, the articular surface in the osteoarthritic knee could be severely damaged due to the degeneration process. Therefore, it is difficult to measure the native joint line level preoperatively. We also propose to use the tibial tuberosity as an intraoperative bony landmark for joint line level (Fig. 1). It is commonly believed that the average distance between a fibular head and a joint line is around 10 mm. Preoperatively, the surgeon could measure the distance between tibial tuberosity and the tip of the fibular head. Then by adding 10 mm to the result, the surgeon could roughly determine the level of the joint line. Knowing this joint line level is highly important when performing revision TKR surgery to prevent elevation of a joint line which could affect the extensor mechanism of the knee.

Based on the previous study several anatomical landmarks on the proximal tibia have been used to determine tibial rotational alignment in TKA such as determining tibial rotational alignment in TKA, including the medial one-third of the tibial tuberosity, medial border of the tibial tuberosity, the apex of the tibial tuberosity, midsulcus line, and medial border of the patellar tendon (Sahin *et al.*, 2013; Dalury and Aram, 2016; Kim *et al.*, 2017). Average finding on tibial tuberosity to tip of fibula are 19,37 and 18,31 mm. Interpretation closely related with gender differencies between males and females (Nieves *et al.*, 2005).

The important findings of this study were as follows : (1) the overall average distance between tibial tuberosity to the tip of the head of the fibula is 18,57 mm and (2) the highest distance was 27,64 mm. Almost similarly to

described by another literature, tibial tuberosity is located at around 30 mm below the condylar of the tibia (*Farlex Partner Medical Dictionary*, 2012). Another previous study measures the distance of tibial tuberosity to the joint line with an average of 22 mm by using MRI, while the distance of fibular head to the joint line was 14 mm (Servien *et al*., 2008).

There was some limitation in our study. Plain radiograph photos were taken by more than one radiographer. The angle and position to acquire knee radiograph were crucial to making a proportional measurement. Some different radiograph magnification could have still occurred. However all of the samples fulfill the requirement as a true lateral knee photograph criteria, which shows both of femoral condyle superimposed, proximal tibiofibular joint obscured owing to the slight overlap of a head of the fibula on the tibia, a shaft of fibula projected posteriorly about the shaft of the tibia (Unett *et al*., 1997; Lampignano and Kendrick, 2018). To confirm our findings, further study is needed by using MRI/CT images.

CONCLUSIONS

The tibial tuberosity is an easily identified landmark during TKR procedure. We recommend the distance of 18,57 mm from tibial tuberosity as the maximum resection limit in proximal tibial cut during TKR This distance also could be used as a rough guide to defining a level of the joint line by adding 10 mm to it.

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