

High Posterior Tibial Slope Influence Medial Meniscus Injuries in ACL Deficient Knees

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The purpose of the current study was to evaluate the correlation between the tibial slope and medial meniscus injury in anterior cruciate ligament deficient knees. A total of 223 patients with primary ACL injury admitted to Foisor Orthopedic Hospital between 2015-2016 were included in this study. The posterior tibial slope was evaluated on a lateral x-ray view of the knee and was defined as the angle between the line joining the tibial plateau and the line perpendicular to the longitudinal axis (the proximal tibial anatomical axis). Patients were divided into two groups depending on the posterior tibial slope (<9.9 and ≥ 10), and a Chi square test was used to evaluate if there is any correlation between this and internal meniscus injuries, and Fisher's exact test was used to verify this. Overall medial meniscus lesions were found in 43.5% of the patients. The mean value of the posterior tibial slope was 11.19 ± 2.685 . After grouping patients in low and high group (<9.9 and ≥ 10), there were 66.8% in the high tibial slope group and 33.2% in the low group. In the high PTS group there were 93 patients with medial meniscus lesion (62.4%), and 56 (37.6%) without medial meniscus lesion. The mean posterior tibial slope was higher in the medial meniscus tear group (11.78 degrees), than mean PTS in the group without medial meniscus lesion (10.42 degrees). There was a strong correlation between high tibial slope and medial meniscus lesions ($p=0.015$). The main finding of the current study is that there is a statistically significant correlation between posterior tibial slope higher than 10 degrees and internal meniscus tears.

Keywords: posterior tibial slope, medial meniscus injury, ACL lesion

Recently there is a high interest in the association between increased posterior tibial slope and medial meniscus tears in anterior cruciate ligament (ACL)-deficient knee. It is well demonstrated that ACL is a primary restraint in anterior tibial translation [1].

The association between posterior tibial slope and anterior tibial translation was also demonstrated by Dejour, who showed that anterior tibial translation in weight bearing stance correlates with posterior tibial slope and this is higher in ACL deficient knees[2]. The medial meniscus is thought to limit anterior tibial translation in ACL deficient knees primarily by its posterior horn acting as a wedge against the posterior aspect of the medial condyle[3]. The role of medial meniscus in resisting anterior tibial translation in ACL-deficient knees was also demonstrated by Shoemaker who showed greater tibial displacement after meniscectomy in loaded knees[4].

The objective of the current study was to evaluate the correlation between the posterior tibial slope and medial meniscus injury in ACL deficient knees. The hypothesis was that individuals with higher posterior tibial slope and ACL deficiency are at a greater risk of having medial meniscus tears than those with a low posterior slope and ACL deficiency.

Experimental part

The current study is a retrospective study based on the data registered in the National Registry of Ligamentoplasty. It included 223 patients, who underwent primary ACL reconstruction at Foisor Orthopaedics Hospital between 2015-2016. The mean age at surgery was 30 years, with limits between 15 and 48 years. The exclusion criteria were represented by associated surgery such as HTO or revision ACL surgery. There were 182 males and 41 females (81.6 and 18.4%). The study was approved by the Institutional Review Board.

Demographic data and data about ACL and meniscal injuries were collected. All patients were evaluated according to a similar protocol which included antero-posterior, lateral and skyline views of the knee. The x-rays were evaluated using the hospital's PACS system[5], to view the radiographs and digitally measure the posterior tibial slope on the affected knee, which was done by a single observer. To determine the posterior tibial slope, a method previously described by Dejour was used [2]. A line is drawn down the proximal tibial anatomical axis on a true lateral radiograph which gives high reliability among the tibial axis[6]. Then a line is drawn from the peak anterior and posterior points on the medial tibial plateau. The posterior tibial slope is defined as the angle between the line tangent to the tibial plateau and the line perpendicular to the longitudinal axis (fig. 1).



Fig. 1.

A total of 43.5% of the patients had a medial meniscus injury at the moment of surgery, and 16.6% had lateral meniscus injuries. Regarding posterior tibial slope values between 4 degrees and 16.2 degrees were found, with a mean value of 11.19 ± 2.685 . There were 66.8% patients in the high tibial slope group and 33.2% in the low group.

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Because the average PTS measured on lateral radiographs is around 10.3 degrees[2], the PTS limit was set at this value and, the ordinal values of the PTS were recoded in 2 nominal groups (<9.9 degrees and ≥ 10 degrees). The presence of a medial meniscus injury was noted.

A Chi square test was used to search for correlation between nominal data, and it was verified with a Fisher's exact test. The significance levels were set at a p value <0.05 .

Results and discussions

In the high PTS group, 62.4% of the patients had medial meniscus injury, and in the low PTS group there were 44.6% with this type of associated injury. The mean posterior tibial slope was higher in patients with the medial meniscus tear (11.78), than mean PTS in the group without medial meniscus lesion (10.42). There was a strong correlation between high posterior tibial slope and internal meniscus lesions which was statistically significant with a p value of 0.011.

The main finding of this study is that a high posterior tibial slope correlates with increased medial meniscus lesions in ACL deficient knees, and this is similar with data found by other authors[7], who concluded that a PTS over 13 degrees is a risk factor for secondary medial meniscus injury in ACL deficient knees.

Markl et. all. in a study based on MRI measurement of posterior tibial slope found a higher incidence of meniscal injuries associated with higher tibial slope in ACL deficient knees. However in their study this correlation didn't reach statistical significance [8].

Medial meniscus lesions were found in 43.5% of the patients in the current study, which is consistent with values found in similar studies[7]. The incidence of lateral meniscus injuries in our study is lower than the incidence found in other studies[7,9], but is also consistent with the results found by Dejour[2], who found 15 lateral and 9 bilateral meniscal injuries in a group of 113 patients.

It is hard to set a limit to classify posterior tibial slope as high or low, because values between 7 and 13 are said to be normal [10,11]. In this study the values of the posterior tibial slope were between 4 degrees and 16.2 degrees, with a mean value of 11.19 ± 2.685 , which is consistent with other literature studies [2,7].

In the literature there isn't a consensus regarding radiographic measurement of the posterior tibial slope, because different longitudinal tibial axes are currently used[2,6,12-15]. Some authors are using the posterior tibial cortex axis as a reference for measuring the posterior slope[16], because it isn't influenced by age, sex, height or body mass as Brazier showed[6]. Others advocate for PTAA as a measuring reference [2,7,15]. However the values for posterior tibial slope measured with posterior tibial cortex as reference are smaller than the ones found by measuring it with proximal tibial anatomical axis[17], which may explain the values found in our study. Using the PACS system makes it easy and reliably to measure the posterior tibial slope[5]. Faschingbauer says that PTS can only be approximated on short lateral knee radiographs and the results will be with approximately 3 degrees too high [14].

After ACL reconstruction, a steep posterior tibial slope could place the graft and fixation material under increased loads during weight bearing, this representing a potential risk factor for early failure[17]. It is known that high tibial osteotomy can change the posterior tibial slope with medial open wedge decreasing it, and lateral closing wedge increasing it[18]. Neyret[19] describes a beneficial effect of decreasing tibial slope in ACL reconstruction combined

with HTO by diminishing anterior tibial translation. Thus, the question arises whether or not an osteotomy for decreasing the posterior tibial slope would be beneficial or not in cases with excessively increase posterior tibial slope. Postma describes a high posterior tibial slope as a non-modifiable risk factor for ACL injury together with notch stenosis, ligamentous laxity, hormonal function and neuromuscular maturation [20].

The tibial plateau is too complex to be characterized only by posterior tibial slope[21], which is a 2D measurement and the tibial plateau should be regarded as a 3D structure, with different posterior slope for the medial and lateral compartment. According to Hashemi [21], it is difficult to differentiate between medial and lateral aspects of the tibial plateau on a lateral radiograph and the true tibial slope should be measured at the center of the tibial plateau, and one should consider the measurement of the depth of medial compartment concavity to better characterize the complex three dimensional aspect of the tibial plateau.

The use of haptic actuators[22] could lower the recovery time after an ACL lesion and increase proprioception after ACL surgery. Moreover, haptic wearables can reduce knee loads by providing motion cues that alter risky walking patterns[23].

The main limitation of the current study is represented by the fact that the measurements were done by a single observer. However, the values found are consistent with those presented in similar studies [2,7].

Conclusions

This current study demonstrates that a high posterior tibial slope correlates with an increased rate of medial meniscus lesions.

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