# THE INFLUENCE OF VASTUS MEDIALIS OBLIQUUS DEFICIENCY ON THE STRAIN STATE OF THE PATELLAR BONE IN TKA

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## Introduction

The causes of anterior knee pain (AKP) after TKA with non-resurfaced patella remains unclear. Weakness of Vastus Medialis Obliquus (VMO) has been frequently associated with patellofemoral pain (PFP) syndrome. It has been shown that VMO weakness may lead to the patellar maltracking. However, there is limited knowledge of its influence on the strain state of the patellar bone. Strain can be used to assess tissue damage. Furthermore, changes in strain state can influence the metabolic activity of the bone cells. This bone remodeling activity may be linked with AKP [Draper, 2011].

The goal of this study was to build a model of the TKA with the non-resurfaced patella to assess the influence of VMO deficiency on the strain state of the patellar bone.

## Methods

A subject-specific finite element model of the knee after TKA was developed in Abaqus/Standard (Simulia, Providence, RI) from a cadaveric CT. The model included the femur, the tibia, the patella with cartilage and the four heads of the quadriceps. Insertion and direction of muscle forces were estimated from literature [Sakai, 1996] and CT. A posterior-stabilized knee prosthesis (FIRST, Symbios, Switzerland) was inserted under supervision of a knee surgeon. Patellar bone was considered as linear elastic material with non-homogeneous mechanical properties. Mapped density-elasticity relationship, $E = 3790\rho_{app}^{3}$ [Carter, 1977], was used.

A loaded (bodyweight = 800 N) squat movement controlled by elongation of Vastus Intermedius was simulated from full extension to 90° of flexion. A special FORTRAN subroutine synchronized the forces in the muscles through a feedback mechanism according to their ratios. Ratios were estimated from PSCA found in literature [Cutts, 1993]. Two cases were compared: normal and deficient VMO. Deficiency of VMO was simulated by reducing its ratio by 50%.

Bone volume of octahedral shear strain were predicted and compared in medial and lateral regions of interest (ROI) in the posterior part of the patella (Fig.1) for the normal and deficient VMO.

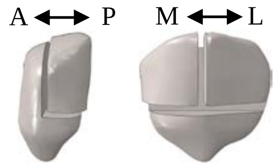


*Figure 1: Medial and lateral ROI in the patella: sagittal (left) and frontal (right) view.*

## Results

Since bone strain did not exceed 0.4% below 70° of flexion, the comparison was performed from 70 to 90° (Fig. 2). The volume of highly strained bone in the lateral part of the patella was 2-fold larger in the case of VMO deficiency than for normal VMO. Conversely, it was twice smaller in the medial part for deficient VMO than for normal VMO.

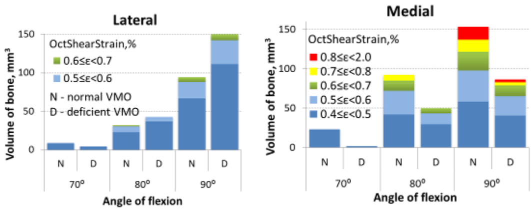


*Figure 2: Strain volume in medial and lateral ROI for normal and deficient VMO.*

## Discussion

Since octahedral shear strain exceeding 0.5% may be associated with bone micro-damage [Carter, 1981], it can be also associated with change in metabolic activity. We thus suggest that increased strains in the lateral part may lead to AKP development. However, further investigations are needed to assess a critical level of bone strain and volume leading to AKP.

## References

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