EFFECT OF ACL STRENGTH ON STRESS DISTRIBUTION OF MENISCUS WHEN LANDING FROM A JUMP

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■ INTRODUCTION

Acute anterior cruciate ligament (ACL) injury usually associates with meniscal injury, the incident rate of tear either in medial or lateral meniscus is about the same [1]. However, the sport type may have different pattern of meniscal injury. Paletta reported that the incidence of isolated lateral meniscal injury in skiers was higher than in nonskiers [2].

The ACL is easily injured when landing from a jump. The purpose of this study was to investigate how the injured ACL altered the weight bearing posture of lower limb and resulted in rupture of meniscus in simulation of basketball jumping.

■ METHODS

The knee joint FEM model was generated from a series of MRI images scanned from a 24 years old male, then analyzed using dynamic finite element software (LS-DYNA). In simulation, the musculoskeletal knee model was assumed to be cylinders (thigh and shank) and sphere (knee joint). The input conditions of applied segmental forces and joint ranges of motion were obtained from the inverse kinematics of basket ball simulation using a force plate (AMTI), EMG and motion analysis system (VICON). The muscle force of quadriceps was calculated from isometric test (BIODEX, USA) and the forces of gastrocnemius and hamstring were proportional to quadriceps according to the EMG magnitude. The constructed model was validated first using the data acquired from kinetic and kinematic analysis. After validated the model, the simulations were carried in four ACL strength conditions 100%, 80%, 50%,0%.

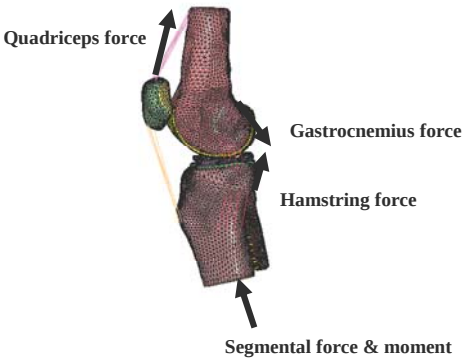

Figure 1: Knee dynamic model with distal femur, proximal tibia, patella, meniscuses and muscles

■ RESULTS AND DISCUSSION

The results showed that when single leg landing from vertical jump, the knee joint performed internal rotation and adduction. ACL and MCL were the major acting ligaments to stabilize the joint capsule. In the case of 100% ACL strength, the meniscus had the von Misses stress of 4-8Mpa evenly distributed over medical and lateral meniscuses. When ACL strength decreased, the tibia moved forward profoundly to femur, which resulted in more internal rotation and knee valgus, as well as increased the load on MCL. The weight bearing stress moved to lateral meniscus. When the ACL was completely ruptured (0% strength) the lateral meniscus had the maximum von Misses stress of 44.6Mpa acting on posterior region, the medial meniscus took only 0.8 Mpa stress (Fig2).

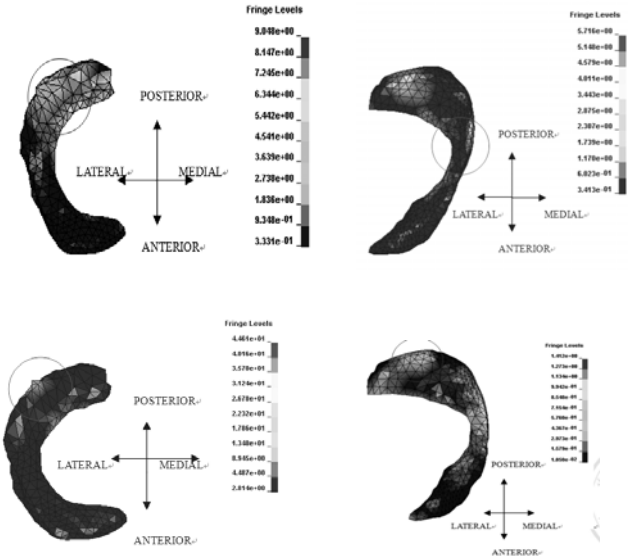

Figure 2: The maximum von Misses stress increased at posterior region of lateral meniscus (7.24Mpa to 44.61 Mpa), but decreased at the medical meniscus (3.73Mpa to 0.90Mpa) when the ACL strength was from 100% to 0%.

■ CONCLUSIONS

Changing the ACL strength will result in the knee weight bearing shift laterally and increases the load on the lateral meniscus, and then causes the meniscal injury. The injury pattern is likely a longitudinal tear of the posterior horn at the lateral meniscus.

ACKNOWLEDGEMENTS

This study was supported by National Science Council of ROC, through the grant NSC 96-2221-E-010 -004 -MY3.

■ REFERENCES

1.Kenichi O, et al, *Arthroscopy*, 28(2):203-209, 2003

2.. Paletta GA, et al, *Am J Sports Med*, **20(5):** 542-547, 1992.