Time dependent properties of bovine meniscal attachments: Stress relaxation and creep

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Abstract

It has been suggested that the success of a meniscal replacement is dependent on several factors, one of which is the secure fixation and firm attachment of the replacement to the tibial plateau [Chen, M.I., Branch, T.P., et al., 1996. Is it important to secure the horns during lateral meniscal transplantation? A cadaveric study. Arthroscopy 12(2), 174–181; Alhalki, M.M., et al., 1999. How three methods for fixing a medial meniscal autograft affect tibial contact mechanics. American Journal of Sports Medicine 27(3), 320–328; Haut Donahue, T.L., et al., 2003. How the stiffness of meniscal attachments and meniscal material properties affect tibiofemoral contact pressure computed using a validated finite element model of the human knee joint. Journal of Biomechanics 36(1), 19–34]. The complex loading environment in the knee lends itself to different loading environments for each meniscal attachment. We hypothesize that the creep and stress relaxation characteristics of the horn attachments will be different for the anterior versus posterior, and medial versus lateral attachments. To test this hypothesis, the stress relaxation and creep characteristics of the meniscal horn attachments were determined. The stress relaxation properties of load/stress at the end of the test, and the load/stress relaxation rate demonstrated no significant statistical differences between the attachments. Unlike the stress relaxation properties, the creep properties demonstrated some significant differences amongst the attachments. The normalized displacement at the end of the test, normalized creep rate and strain creep rate for the lateral anterior attachment were significantly different than those of the medial posterior attachment (p<0.05). The two anterior attachments had significantly different strains at the end of the test, as well as significantly different creep strain rates (p<0.05). The two attachments of the medial meniscus revealed no significant differences between any of the creep properties measured (p>0.05). The time dependent properties obtained in this experiment provide insight into the behavior of meniscal horn attachments under various loading situations. The results indicate that a suitable meniscal replacement may require different properties for the lateral and medial horns.