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Femur flap for tibial reconstruction:
% Circumference Required to Convey a Mechanical Advantage over the Fibula

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Background: A free-vascularized fibular flap is commonly used to reconstruct the tibia following a large segmental loss of bone. However, the fibular flap is associated with a high risk of post-operative fracture despite long-term non-weight bearing status of the reconstructed limb. A flap with greater structural strength is desirable to reduce post-operative flap fractures and also to possibly decrease the length of time of non-weight bearing status. A flap using a non-circumferential piece of the distal femur is proposed. The flap would receive its vascular supply from the overlying vastus intermedius muscle via the descending branch of the lateral femoral circumflex artery.

Objectives: The purpose of the study is to determine the size of the femur flap that is required to produce greater structural strength than the fibular flap and the donor site morbidity of taking such a flap.

Methods: Femurs and fibulas were harvested from eight preserved cadavers ranging in age from 75 to 95 years old. The structural strength of the fibular and femur flaps was assessed using a three-point bending technique. Flaps 10 cm in length were tested in each case. In order to produce a rough estimate of the circumference of femur necessary to exceed the strength of fibula, flaps of 15 to 30% of the femur circumference were cut and compared to fibula. A flap of 35% femur circumference was of adequate strength based on the initial testing and five 35% flaps were cut for analysis, along with four 40% flaps. In addition, uniaxial compression testing was performed on the osteotomized and whole femurs to assess to the donor-site morbidity of taking a 35% or 40% flap.

Results: The 35% flap was significantly stronger than the fibula ($p = 0.002$). The uniaxial compression testing of the femurs revealed that there was a change in failure location from the neck to the shaft of the femur with the removal of the flap. The average maximum load

tolerated by the intact femur was 840 +/- 297 pounds, while in the femurs with the 35% flap removed the average maximum load at failure was 810 +/- 235 pounds. However, the osteotomized femur with the 35% flap removed was not significantly weaker than the whole, uncut femur ($p = 0.847$).

Conclusion: A flap consisting of >35% of the circumference of the distal femur exceeds the structural strength of the fibular flap. This femur flap seems to be a promising alternative to the commonly utilized fibular flap. Taking such a flap appears to weaken the femur slightly and change its structural integrity. Fixation of the femur may be prudent following harvest of this flap.