MECHANICAL EFFICACY OF TENDON TRANSFER OPERATIONS FOR FOOT DROP

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INTRODUCTION

There are multiple operations described for foot drop. Conventional posterior tibial tendon transfer through the interosseus membrane (IOM) is popular, but there are concerns that it may not be adequate to obviate continued bracing. The Bridle procedure (BRI) is promising [1] but involves 5-7 incisions and a higher potential for complications. The purpose of this study was to compare results of these two operations in cadaveric lower extremities using a dynamic ankle-foot simulator.

METHODS

Seven fresh-frozen lower extremities without foot-ankle pathology were evaluated. The tibia and fibula were embedded in PMMA and specimen mounted in a previously-validated dynamic ankle-foot simulator [2], designed to recreate late swing phase and entire stance phase of gait in cadaveric specimens (Fig 1). Input data derived from anatomic, electromyographic, and gait analysis studies were used for ground reaction force profiles, tibial advancement, and application of forces to 6 distinct muscle groups. Axial and fore-aft shear forces were applied with servomotors, with profiles from gait analysis data [3]. Each specimen was pre-tested three times to reduce viscoelastic effect of soft tissue structures.

Three-dimensional kinematics were measured using a magnetic tracking device (3Space Fastrak system, Polhemus, Colchester, VT), focusing upon metatarsal motion relative to talus. Motor control and data acquisition were accomplished using Labview (National Instruments, Austin, TX). Specimens were tested in 4 conditions: 1) intact, 2) foot drop (tibialis anterior, extensor hallucis longus, extensor digitorum longus, and peroneals forces removed), 3) after IOM, and 4) after BRI. Statistical analysis included repeated measures ANOVA to evaluate the effect of each test condition on foot kinematics, with statistical significance set at $p<0.05$ level.

RESULTS AND DISCUSSION

Typical metatarsal-tibial sagittal motions for normal, foot drop, BRI and IOM are shown in Figure 2. The position of the foot at initial contact in all three planes differed significantly between the intact and foot drop conditions, with the intact foot in a position of dorsiflexion (4.6±5.5 deg), eversion (4.4±4.9 deg), and external rotation (3.3±6.3 deg) and the foot drop in a position of plantarflexion (-18.5±5.4 deg), inversion (-13.1±3.8 deg), and internal rotation (-9.8±6.1 deg). Both operations improved foot position, as compared to foot drop, in all three planes. Neither the IOM nor the BRI conditions differed significantly from the intact condition, except for the sagittal position of the foot after the BRI procedure.

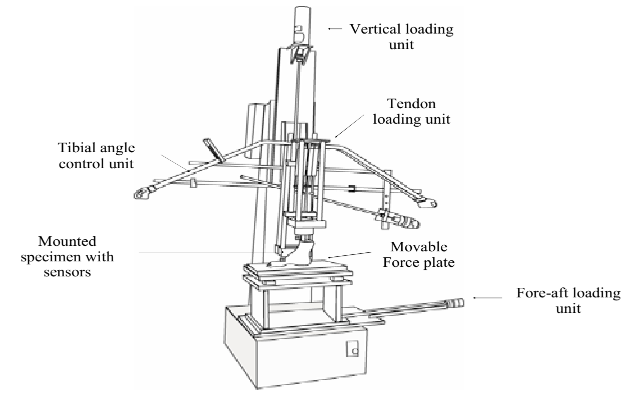

Figure 1: Dynamic ankle-foot simulator.

CONCLUSIONS

These data suggest that the IOM and BRI procedures were successful in restoring the kinematics of the foot at heel strike in this cadaveric model of gait. The mechanical effects of these two procedures are similar, suggesting that either may be employed for the improvement of gait in patients with foot drop.

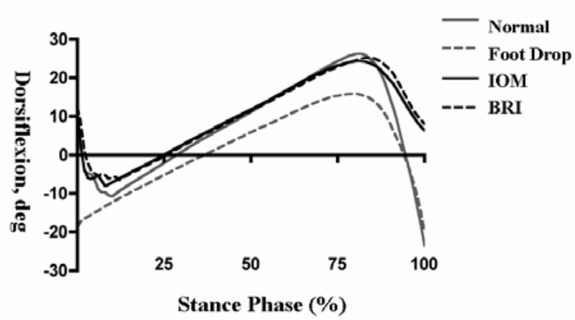

Figure 2: Metatarsal-tibial sagittal motion in intact, foot drop, IOM, and BRI conditions.

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ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance and support of: S. Ringleb, K. An, T. Tsubone, X. Crevoisier, and the Mayo Foundation.