INTRODUCTION

Total ankle arthroplasty (TAA) has become more viable due to advances in materials, design and techniques. The procedure can restore functionality and offer patients an alternative to arthrodesis while still preserving adequate bone stock for possible fusion. Although TAA avoids arthrodesis, functional deficits may still remain. All TAA procedures will disrupt the joint capsule and may include additional procedures, such as syndesmosis fusion. The procedure may improve functionality but may still cause sufficient peripheral nerve damage to alter important aspects of joint function. In particular, TAA may impair proprioceptive feedback to the central nervous system and the proprioceptive ability after TAA remains unknown.

Proprioception can be considered to consist of both the ability to sense joint position and joint movement. The current work considers only the ability of the ankle to sense joint position and proceeds from the null hypothesis that unilateral TAA patients will have the same joint position sense on the operated and unoperated sides. Patients with underlying joint pathologies on the unoperated side were not considered for participation in the study.

METHODS

A device with servocontrolled actuation was constructed to test all aspects of ankle proprioception. On opposite sides of a 32 cm square aluminum base platen, two 20 cm tall aluminum struts were attached perpendicular to the platen surface to form a U-shaped cradle. A test subject placed her/his foot on the platen and any desired angle of foot inclination could be achieved through rotation of the cradle about an axis through the upright struts of the U-shape. A stiff caged belt connected the cradle to the servomotor, which could move in 0.08° increments.

The struts had a 3:1 difference in diameters so that positioning could achieve a theoretical accuracy of 0.027°.

The ability to position the foot at a target angle was tested. Subjects wore 30 dB sound insulating ear protection and light plastic laboratory eyewear which had the lower half blackened to obscure the subjects’ view of the foot and platen. Subjects were seated in a chair which had panels attached along the sides and soft straps held the subject’s knee to the panels at a 90° of flexion angle. The platen was adjusted to hold the ankle neutral. The platen height was set so that the axis of rotation passed through the midpoint of the maleoli; for inversion/eversion tests, the platform was turned 90° and the platen height adjusted as necessary. The platen was parallel to the floor and the foot was held to the platen by strong, but soft, straps. The straps were held in place by the topless soles of patient-specific tennis shoes attached to the platen.

Subjects were asked to reposition the ankle joint to specific target angles. An operator commanded the servomotor first to move the platen to a set angle and then to return to neutral. After the return to neutral, each subject had active control of the platform through a joystick manipulator. The joystick sent commands to the servomotor for rotation of the cradle about an axis through the uppright struts of the U-shape. A stiff caged belt connected the cradle to the servomotor, which could move in 0.08° increments.

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The similarity of all test types indicates that subjects sensed each position equally well and that the proprioception device functioned as intended. However, the finding that no difference between tests was statistically significant was somewhat surprising; larger angles could have meant larger errors (Glencross). The difficulties of several subjects in sensing small angles suggested that the small movements may have been insufficient to evoke strong responses. To test differences between the tests themselves to a finer degree, the three plantar flexion tests, and each pair of the dorsiflexion, inversion and eversion tests were compared separately with ANOVA’s. This comparison found that the plantar, inversion, and eversion tests were not distinguished from each other, but that the dorsiflexion tests of 5° and 10° were discerned. Namely, subjects could distinguish dorsiflexion better than any other movement. This finding may reflect the particular abilities of TAA patients and future work could push each subject to her/his range of motion limits.

DISCUSSION

The confirmation of the null hypothesis indicated that TAA does not alter position sense at the ankle, a factor never previously examined in ankle replacement. Other researchers have studied position sense in the knee and ankle and found varying effects with pathology. Gross (1986) studying the ankle and Bennet et al. (2003) studying the knee found no relationship between an underlying pathology and joint position sense. Glencross and Thornton (1981), however, found that the severity of ankle sprain had an effect on passive plantar position sense. The movements included by Glencross and Thornton included more extreme movements, which were not included in the current work due to considerations of a more restricted range of motion after TAA.

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The detection of movement was not tested in this study. Future and continued work with the same subjects may help determine if kinesthetic awareness and position sense vary within a group suffering from a specific pathology, thereby contributing to an understanding of general proprioceptive pathways.

REFERENCES


**Duquesne University, Pittsburgh, PA

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