The effect of subtalar arthrodesis for the correction of Adult Acquired Flatfoot Deformity on lower limb kinematics and in-shoe plantar pressure

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Summary

Adult Acquired Flatfoot Deformity (AAFD) is characterized by the collapse of the midfoot often resulting in foot pain. This study examined the effects of the surgical correction of AAFD via subtalar arthrodesis, using a modified Grice technique, on relevant biomechanical parameters in the foot. Lower limb kinematics and in-shoe plantar pressure were recorded in ten AAFD patients before and after surgery. At post-op, patients showed improved foot bone alignment, reduced calcaneal eversion, and improved plantar pressure distribution. The medial midfoot contact area significantly decreased (pre-op: 6±1%; post-op: 3±1%; $p<0.01$), and a "lateralization" of the trajectory of the center of pressure was observed at post-op. These findings suggest that, in accordance with clinical outcomes, subtalar arthrodesis improves foot function and plantar pressure distribution in AAFD patients.

Introduction

Adult Acquired Flatfoot Deformity (AAFD) is characterized by the collapse of the structures comprising the medial longitudinal arch of the foot and can be associated with functional impairments and pain. The flattening of the arch typically results in significant increase of the plantar surface contact area and alterations in plantar pressure distribution [1]. When conservative treatments fail to provide sufficient symptoms relief, surgical intervention may be warranted. This study aimed at assessing the effects of subtalar arthrodesis on foot and ankle kinematics and in-shoe plantar pressure parameters during gait in patients with AAFD.

Methods

Ten AAFD patients signed informed consent to volunteer in the study. Functional evaluation of patients was performed pre- and post-surgery following subtalar arthrodesis of the affected foot using a modified Grice technique (Fig.1a) [2, 3]. Lower limb kinematics were collected during gait via an 8-camera motion capture system using skin-marker based protocols [4]. In-shoe plantar pressure was measured via in-shoe pressure insoles featuring 99-capacitive sensors fitted in the same minimalist footwear for all patients. Relevant plantar pressure parameters were calculated for the hindfoot, midfoot and forefoot regions, and for the full plantar surface. Spatial and temporal normalization of the Center of Pressure (CoP) trajectory was performed to allow inter-patient comparison. Paired Wilcoxon test was used to evaluate the effect of surgery on kinematic and plantar pressure parameters ($\alpha=0.05$). Post-op data were compared to those from a healthy control group (n=27). Differences in the temporal profiles of kinematic data were evaluated via Statistical Parametric Mapping.

Results and Discussion

Significant reduction in calcaneus and overall foot eversion were observed at post-op. Forefoot-to-hindfoot inversion was also reduced, likely due to the calcaneal realignment. Overall, the surgery met its primary objective by realigning the calcaneus in the frontal-plane and reducing the maximum calcaneal eversion. This was reflected in a lateralization of the in-shoe pressure distribution and in significant reduction of the medial midfoot contact area (pre-op: 6±1%; post-op: 3±1%; $p<0.01$). The CoP trajectory was more similar to the control data following surgery (Figure 1b).

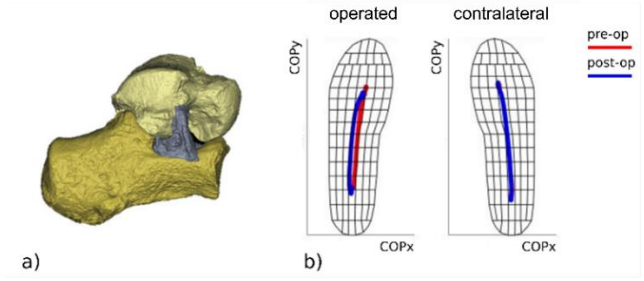

Figure 1: a) 3D reconstruction of the hindfoot bones from weight-bearing CT after surgery; the arthrodesis bone graft is shown in gray; b) average in-shoe COP trajectory at pre-op (red) and post-op (blue) across all patients in the operated (left) and contralateral foot (right).

Conclusions

This study provides further evidence supporting the efficacy of subtalar arthrodesis in enhancing foot function and optimizing plantar pressure distribution in patients with AAFD. The integration of kinematic and pressure data aligns with clinical outcomes, substantiating the hypothesis of reduced foot pronation post-surgery.

Acknowledgments

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