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Letter to the editor regarding "Finite element analysis of subtalar joint arthroereisis on adult-acquired flexible flatfoot deformity using customised sinus tarsi implant"

Dear editor

We read with interest the article by Wong DW et al. [1]. We appreciate the authors' efforts to compile the latest finite element analysis of subtalar joint arthroereisis using customised sinus tarsi implant. We agree with the authors' opinion that shape mismatch of the implant is an important problem, contributing to localised stress, pain, and even talus fracture [2]. However, there are areas of concern that must be addressed.

The authors defined "customised sinus tarsi implant" as modeled by the reconstructed geometry of the sinus tarsi so that the boundaries of the implant were filleted. The authors set the interaction between the implant and the bone as frictionless to allow the implant to slide around the bone. However, we question the statement of "customised sinus tarsi implant". Kleipool's study showed the dimensions of the tarsal sinus and canal change according to different foot positions [3]. It means foot position changes during gait, leading to dimensions of the tarsal sinus and canal changing. Therefore, the origin implant of customization shall certainly get unmatched. From this, we tell neither what is geometry of the sinus tarsi and canal nor how to define a "customised sinus tarsi implant". From our perspective, investigating the proper foot position may be the key point to "customised sinus tarsi implant". Graham et al. believed the goal of subtalar arthroereisis was to restore the motion to a normal range of hindfoot pronation, which is 3°–5° [4]. 3°–5° hindfoot pronation may be a referenced position, which, however, needs further study to verify. Although the authors stated that the ankle joint was put at 90° with minimal support or compression on the plantar foot during the scan, it was far from adequate information. Kleipool's study indicated the dimensions of the tarsal sinus and canal were affected mainly by eversion or inversion and less by dorsiflexion or plantarflexion [3]. The exact foot position when creating the model of customised sinus tarsi implant does matter. Furthermore, we notice that the implant brings stress concentration at the sulcus tali and the sinus tarsi (Fig. 5 [1]). As mentioned above, we cannot exclude the influence which shape mismatch of the implant during gait brings. Finally, as the authors stated, we agree taking the dynamic change of the sinus tarsi and canal into account is a promising direction for future research of the customised implant.

Finite element analysis (FEA) has been used for translation of engineering to medicine, especially in the field of orthopedics [5]. There have been several FEA studies on subtalar arthroereisis in flexible flatfoot deformity [1,6,7]. Xu et al. [6] found the type II sinus tarsi implant displayed a stronger effect than that of type I, including plantar stress distribution, peak von Mises of the medial and lateral columns, strain of the medial ligaments and plantar fascia, and deformity correction. To note, the shape of type II sinus tarsi implant mimics the space and orientation of tarsal sinus and canal, hence, it is more of anatomic fit compared with type I implant. However, even type II sinus tarsi implant couldn't restore the internal load transfer and midfoot stress [7], for it was not a real "customised sinus tarsi implant". We deem this may have relationship with geometry mismatch of implant shape, which also demonstrates the importance and necessity of developing customised sinus tarsi implant from a sideways perspective. Further, we are delighted to see that real-time analysis of the dynamic foot function is under research and development via FEA [8]. Taking into account dynamic change during gait is of great value, making FEA of foot more realistic and accurate. In brief, we believe FEA has a promising future in developing customised sinus tarsi implant.

In our opinion, a real sense of a customised sinus tarsi implant is difficult to acquire. Choosing a critical foot position may help establish the model of a relatively customised sinus tarsi implant. To reach this goal, FEA provides a feasible method to simulate complex conditions authentically. Further studies are warranted, which analyze the force situation with different customised sinus tarsi implants according to the dynamic change of the sinus tarsi and canal.

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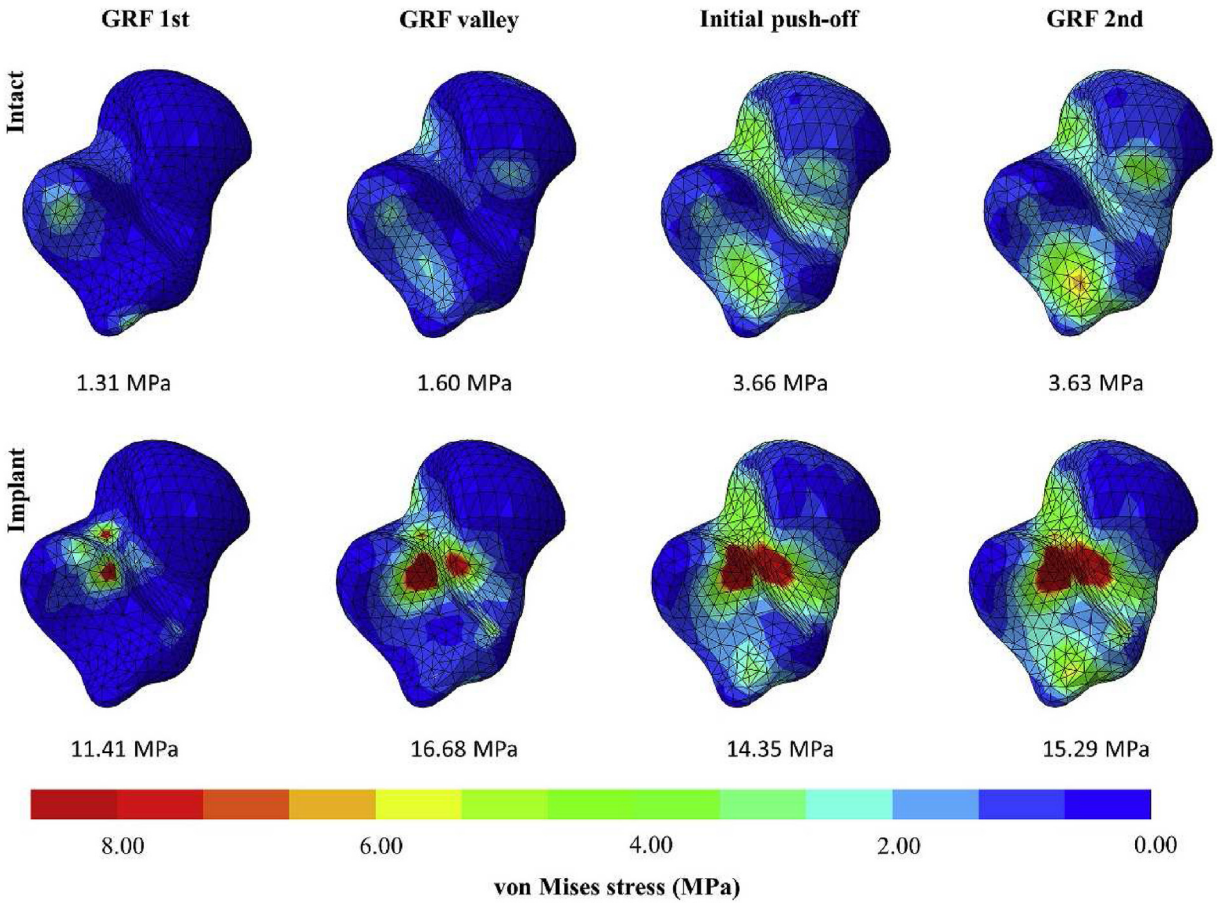

Figure 5. Von Mises stress of the talus and the average von Mises stress values of the concentrated stress region at the sulcus tali and sinus tarsi between the intact and implant conditions during gait (Inferior view) [1].

Declaration of competing interest

The authors declare no conflicts of interest.

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Cheng Chen
Department of Orthopaedics, Shanghai Jiao Tong University Affiliated Sixth Peoples Hospital, Shanghai, 200233, China

ZhongMin Shi*
Department of Orthopaedics, Shanghai Jiao Tong University Affiliated Sixth Peoples Hospital, Shanghai, 200233, China

* Corresponding author. Department of Orthopaedics, Shanghai Jiao Tong University Affiliated Sixth Peoples Hospital, Yishan Road 600, Xuhui district, Shanghai, 200233, China.
E-mail address: liuyuanzuhuai@163.com (Z. Shi).