Contoured foam cushions in spinal cord injury care: Cinderella's shoe does not fit anymore!

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Introduction

Guidelines for preventing sitting-acquired pressure ulcers (PUs) repeatedly recommend the use of soft and thick cushions designed for distributing buttocks-support loads, particularly on wheelchairs. Recently, it was suggested that contoured foam cushions (CFCs) which fit the individual's buttocks shape could provide good efficacy since they create large buttocks-cushion contact areas [1]. We surmise that this is a false premise, since it neglects consideration of the complex changes in the bodies and tissues of patients post a spinal cord injury (SCI), which have recently been thoroughly reviewed in [2]. The changes post SCI, which include bodyweight changes, loss of muscle mass and increase in extra- and intramuscular fat mass in the buttocks, adapation of the pelvic bony structures to the chronic sitting (to mention just a few), essentially alter the buttocks structure over a time of several months to a year or so post the injury. The buttocks (and rest of the body) continue to change later in life as well, typically more gradually, but changes constantly take place. To test the hypothesis that CFCs may become irrelevant to the individual's body within a short period after the fitting procedure due to the aforementioned pathoanatomical and pathophysiological changes, we designed a finite element (FE) modeling study.

Methods

A set of FE models was developed, describing different severities of changes in fat mass, in combination with muscular atrophy and intramuscular fat infiltration (IMFI), and their biomechanical effects when sitting on a CFC fitted near the time of SCI. The ScanIP® module of Simpleware® was used to segment the tissue components from a coronal MRI slice of the left buttock of a subject with a SCI. Then, variant fat masses were introduced to account for weight loss or gain; muscle atrophy and IMFI were artificially incorporated in several cases. Boundary conditions were determined using PreView of FEBio, and included vertical descent of the upper surface of the model which simulated weight-bearing. All models were run and post-processed in FEBio and PostView.

Results

An example of the dramatic increase in tissue stress levels in the modeling, where a 40%-increase in fat mass was simulated, is provided in Fig. 1. Overall, all the simulated pathoanatomical changes resulted in substantially greater effective and shear strains and stresses in the muscle and fat tissues of the buttocks.

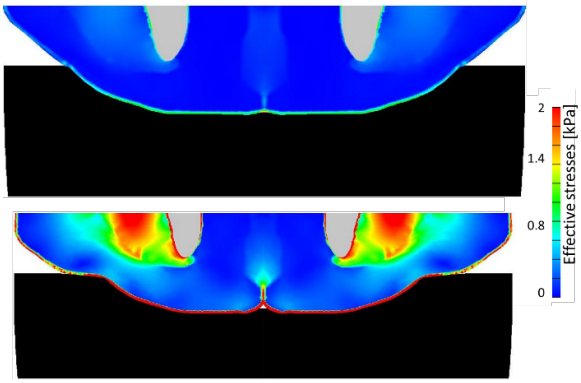

Fig. 1. Effective stresses developed in the buttocks near the time of fitting the cushion (top frame) and later in life, when 40%-increase in fat mass occurs (bottom frame). Note that the stress scale is the same in the two cases.

Discussion

Weight loss and gain both resulted in greater strain and stress values in fat and muscle tissues on the CFC, with the more dominant effect occurring in fat strain levels. The elevated internal tissue loads after weight loss occurred mostly due to tissue compression and tension as tissues were not fully confined in the cushion anymore. Increased tissue loads in the overweight simulations were mostly a result of a sharp rise in internal shear, particularly in fat; the increased shear being due to the "step" in the contour of the CFC, pushing and constraining movements of skin and subcutaneous fat when the body immerses.

Clinical relevance

We provide modeling evidence that there is a fundamental problem in using non-adjustable CFC for clients with SCI, since the body and tissues undergo progressive changes after the SCI, to which these cushion types cannot accommodate.

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Conflict of Interest

None.

References

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