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Retractors with rounded profile preserve soft tissues from excessive loading during surgical exposure

Honold S.[1], Loosli Y.[1], Ganz R.,[2] Küffer J.[3] and Gasser B. [1]

1 RMS Foundation, Bettlach, Switzerland.
2 Orthopaedic Surgery, University Clinic, Bern, Switzerland.
3 accuratus Ltd, Bern, Switzerland.

Introduction:
Orthopaedic operations often request retractors to expose the desired anatomical regions. While displacing muscles, retractors generate considerable loading that eventually affects the tissue irreversibly. Classic retractor designs exhibit a flat rectangular profile with sharp edges, which are the potential origin of stress concentrations. Recently alternative designs having rounded profiles are supposed to substantially reduce the muscle loading. To challenge this hypothesis, a conceptual finite element analysis (FEA) is performed on simplified geometries.
Methods:
The stress distribution, generated by a retractor on a rectangular muscle section, is computed with a two-dimensional FEA. Muscle is modelled as hyperelastic, whereas the retractor is supposed to be rigid. A maximal load of 10N (1kg), corresponding to a displacement of roughly 1cm, is applied on the retractor. A rectangular retractor profile (standard design) as well as a rounded one (Subtilis® design) are investigated under the mentioned boundary conditions. Furthermore retractor width is parametrically varied and the corresponding stresses are computed to verify the influence of this critical design parameter.
Results:
Rectangular profile approximately doubles the maximal stress in the muscle compared to the rounded one regardless of the retractor width (34kPa to 75kPa). Furthermore the location of the maximal stress differs: the rectangular profile mostly loads the muscle next to its edges whereas a rounded design increases the load transfer area located in the middle of the profile contact line.
Conclusion:
This conceptual numerical investigation is sufficient to qualitatively compare the loading in muscle induced by the retractors. As expected, rounded profile is more efficient. Indeed for an identical retractor displacement, the muscles undergo half as much stress. Since long lasting soft tissue loading during surgery is crucial regarding the damage due to tears or compression, rounded retractors are less likely to harm the tissue during surgery.