Prosthetic Glenoid Fixation: Lateralisation Of The Centre Of Rotation Of A Fixed-Fulcrum Total Shoulder Replacement Is Not Associated With Suboptimal Glenoid Bone Formation During A Functionally Relevant Loading Protocol

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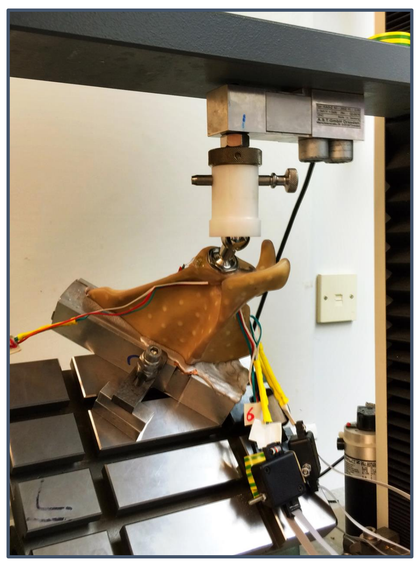
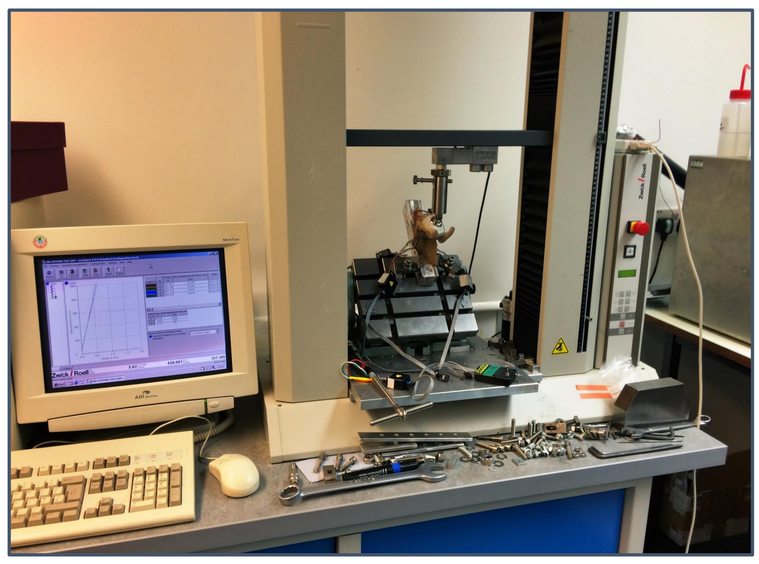
Introduction

- Fixation of large-pitch screwed glenoid prostheses has been shown to be reliable in short term clinical review.
- Optimisation of deltoid biomechanics for better function is desirable.
- Lateralisation of the centre of rotation (COR) might confer advantage to the deltoid, but risks failure of glenoid fixation by increased torsional strain on the implant within bone.
- Osteoblasts subjected to optimal strain within a finite range generate bone (Ruimerman 2005, McNamara and Pendergast, 2007).
- The concept of strain energy density (SED) allows estimation of strain in a unit of material independent of the material structure. SED has been shown to be related to bone formation.
- We designed a protocol to test the potential for advantageous bone formation around a glenoid screw prosthesis with a more lateralized COR.

Methods

- Modified Small Bayley-Walker glenoid screws (Stanmore Implants Worldwide) with a centre of rotation 8mm more lateral than the standard prosthesis were mounted in three Sawbone scapulae with a modulus of elasticity close to cancellous bone.
- Seven stacked tri-element 45° rosette strain gauges were bonded to the scapulae at predetermined points. The prostheses were loaded for 300 seconds at 50 strain gauge samples per second using an in-line load cell in a Zwick rig at four functionally relevant angles at 500Nm.
- Data was entered on LabView GUI and transferred to an Excel database. Linear regression was performed to assess the sensitivity of the data over the complete loading and unloading cycle. The sensitivity was used to interpret the output of the individual strain gauges as counts per Newton.
- The principal strains for each rosette were calculated. The strain energy density (SED) for each rosette was calculated from the principal strains using standard formulae.





Results

- The direction of loading represents the angle of loading relative to the axis of the implant.
- Previous study (Mordecai et al 2011) showed the BW implant (without 8mm lateralisation) loaded the cortical bone at the glenoid vault.
- The average strain energy in the current study with 8mm lateralisation showed similar results with improved strain energy density profile and a (favourable) higher strain around the glenoid rim in all loading scenarios.

Direction of loading	45 abduction	45 anterior/ 45 elevation	45 posterior/ 45 elevation	90 elevation
Position of strain gauge	Average SED (kPa)			
Infraglenoid tubercle	4.2	69.0	2.3	0.2
Central anterior glenoid rim	14.0	35.6	5.9	0.5
Anterior lateral column	2.6	4.1	2.0	0.1
Matsen's point	10.2	3.6	10.2	0.9
Superior anterior glenoid rim	42.0	19.2	50.4	4.7
Dorsal basal coracoid	9.5	60.7	5.2	0.7
Posterior superior glenoid rim	16.0	15.5	19.2	3.5

Conclusion

Lateralisation of the centre of rotation of a linked glenoid screw is not associated with suboptimal bone formation in the scapula.

References

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