Universität Basel

Research Project

Influence of additional weight carrying on load-induced changes in glenohumeral translation in patients with rotator cuff tear - a translational approach

Third-party funded project

Project title Influence of additional weight carrying on load-induced changes in glenohumeral translation in patients with rotator cuff tear - a translational approach
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Project start 01.12.2019
Probable end 30.11.2022
Status Completed

The shoulder is a unique joint: the primary stabilization by the rotator cuff muscles facilitates a large range of motion that is a prerequisite for many daily, occupational and recreational activities. Accordingly, injury to the rotator cuff greatly affects joint function and limits the patients' activities. Rotator cuff tears are a common shoulder injury that sometimes remain undiagnosed because of limited symptoms. However, altered shoulder biomechanics because of injury – even when only subtle – can lead to secondary damage and degeneration including tendinopathy or osteoarthritis. Because of the overlying soft tissue, measuring shoulder biomechanics is complex. Motion of the healthy shoulder primarily comprises rotation with very small to no translation because of stabilization through muscle activity and is affected by muscle cross sectional area (MCSA) and shoulder anatomy including the critical shoulder angle (CSA) and glenoid inclination (GI). Although often clinically observed, inconclusive changes in shoulder translation have been reported in patients with rotator cuff tear. However, to date it is unknown how additional handheld weight similar to situations during daily, occupational or recreational activities affects glenohumeral translation in patients with rotator cuff tear. Based on previous methods for assessing glenohumeral translation, we have developed an in vivo, simulation and ex vivo experimental framework for systematically modulating additional weight during a loading shoulder abduction test that we propose to employ in this study. This framework allows us to assess the dose-response relationship between additional weight and glenohumeral translation termed load-induced glenohumeral translation (liTr). We will address the following specific aims in in vivo, simulation and ex vivo experiments: understanding the biological variation in liTr; understanding the influence of disease pathology on liTr; understanding the potential compensation of rotator cuff tear by muscle activation and muscle size; and understanding the association of liTr and patient outcomes.ăPatients with rotator cuff tears and asymptomatic persons with similar age and sex distribution will be clinically assessed and complete a loading shoulder abduction test while collecting single plane fluoroscopy images. The same test will be repeated while 3-dimensional (3D) motion data and electromyographic data is collected. In the motion analysis test and in the fluoroscopy test, handheld weight will be applied. LiTr will be calculated as the slope of a regression of the negative distance of the glenohumeral centre of rotation (GHJC) to the acromion and studied in relation to patient's functional scores, MCSA, tear size and type, and the CSA and GI. Moreover, we will extent a previously developed shoulder simulator to integrate glenoid specimen, anterior and posterior aspects

of the deltoid muscle and facilitate simulation of individual tendon rupture. Subsequently, we will use this shoulder simulator in simulation and ex vivo experiments to systematically study the effect of tear size and type, CSA and GI in sawbones and human cadaveric specimen. Finally, we will compare results of in vivo, simulation and ex vivo experiments and formulate specific recommendation for clinic and rehabilitation. This study can be considered as proof-of-concept of a potential diagnostic test (loading shoulder abduction test) for glenohumeral translation and will provide first evidence of a dose-response relationship between additional weight and glenohumeral translation. Moreover, the simulation and ex vivo experiments using a shoulder simulator allow the systematic investigation of mechanical compensation for injury to one or more rotator cuff muscles. The results of this study are relevant for diagnostics, treatment and rehabilitation planning in this population.

Financed by
Swiss National Science Foundation (SNSF)

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