CHAPTER 1

General introduction
GENERAL INTRODUCTION

ROTATOR CUFF TEARS – ANATOMY AND PREVALENCE

The shoulder is one of the largest and most complex joints in the body. The glenohumeral joint provides a wide range of motion, but must also be stable to make actions like lifting possible. The joint capsule and the rotator cuff surround the humeral head and glenoid. The rotator cuff is a musculotendinous unit consisting of the M. subscapularis, which inserts at the tuberculum minus of the humeral head, and the M. supraspinatus, M. infraspinatus and M. teres minor, which inserts at the tuberculum majus of the humeral head. The rotator cuff aids the deltoid in elevation and abduction, and initiates rotation.\textsuperscript{1,2} Most importantly, the rotator cuff is a major stabiliser of the glenohumoral joint.\textsuperscript{3} It functions by centralising the humeral head in the glenoid during movement.\textsuperscript{4} The rotator cuff creates a compressive force into the glenoid socket.\textsuperscript{4,5} In a physiological setting a balance between stability and mobility exists in the glenohumoral joint. In case of a rotator cuff tear the humeral head will not be centralised in the glenohumoral joint but may develop an upward migration and eventually an end-stage anterosuperior escape.

The insertion of the supraspinatus and infraspinatus tendon is a thin, crescent-shaped sheet.\textsuperscript{6} Approximately 1cm medially both tendons merge and form a thick bundle of fibres – the rotator cable or suspension bridge.\textsuperscript{7} The posterior rotator cable attachment corresponds to the attachment of the lower infraspinatus. The anterior cable attachment bifurcates around the top of the bicipital groove with part of the attachment corresponding to the anterior supraspinatus and part of the upper attachment of the subscapularis.\textsuperscript{6} As long as the rotator cable attachments are intact, the cuff muscles can produce a distributed load along the cable that gets transferred to bone at the cable attachments (Figure 1). In this way a distally torn rotator cuff can still function by load transmission.\textsuperscript{8,9}
Rotator cuff tears can develop after a traumatic event like a fall or dislocation of the shoulder. Most rotator cuff tears however are of degenerative origin. Extrinsic and intrinsic factors are described as causes of rotator cuff tears. Extrinsic factors are anatomical structures giving compression on the rotator cuff, which can lead to its wear and tear. Neer and Bigliani proposed this ‘impingement’ theory, where the acromion, the coracoacromial ligament or the degenerated AC joint compress the rotator cuff, eventually leading to rotator cuff tears. Suggesting that impingement leads to rotator cuff tears would imply that most such tears are on the bursal side, even though different studies have suggested that degenerative rotator cuff tears start at the articular side. A possible explanation can be internal impingement. During movement (abduction and exorotation) the cuff can impinge on the humeral head, which may lead to wear and tear.

Intrinsic degeneration of the rotator cuff tendon is secondary to age-related changes. Changes in collagen-type synthesis, vascular changes, hypoxia and oxidative stress make the rotator cuff more susceptible to damage. This degeneration, also known as tendinosis, leads to a reduction in the number of functional fibres in the tendon, resulting in an increasing load on the remaining fibres. Degeneration makes the tendon more susceptible to damage;
repetitive stresses cause microinjuries, which are not given enough time to heal before further trauma occurs. In patients with degenerative rotator cuff tears both extrinsic and intrinsic factors play a role. This degeneration-micro trauma explanation is at present the most widely accepted theory on the aetiology of rotator cuff tears. In degenerative rotator cuff tears the tissue quality of the rotator cuff is structurally decreased.

Rotator cuff tears are common in elderly patients. In their fourth decade of life 10% of the population has an atraumatic and symptomatic/asymptomatic partial or full thickness rotator cuff rupture, with numbers increasing to 50% in the sixth decade and 80% in the eighth decade. Degenerative rotator cuff tears can be asymptomatic: 35% of patients with symptomatic full thickness rotator cuff tears are diagnosed with an asymptomatic full thickness rotator cuff tear on the contralateral side. Of these asymptomatic shoulders 50% became symptomatic within five years. Considering the available descriptions of natural history and prevalence studies, it is suggested that in the United States surgery is performed annually on only 5% of all rotator cuff tears. In conclusion, rotator cuff tears are common but do not always give rise to symptoms.

Degenerative changes of the muscle-tendon complex can develop over time following a degenerative rotator cuff tear, such as fatty infiltration, muscle atrophy, retraction of the muscle and decrease of tendon length. Retraction of the muscle belly may lead to a change in the pennation angle between the muscle fibres and the subsequent development of fatty infiltration (Figure 2). When this occurs the elasticity of the muscle decreases.

**FIGURE 2:** Change in pennation angle of a torn and retracted supraspinatus tendon. (Tomioka, sarcomere length of a torn rotator cuff, 2009 JSES)
TREATMENT

Different studies show successful nonoperative treatment of symptomatic, atraumatic, full-thickness rotator cuff tears in approximately 75% of patients. In patients with atraumatic rotator cuff tears treated conservatively the clinical outcome significantly improves after treatment. The improvement in functional outcome, as measured with the Constant Murley score (CMS), ranges between 13.2 and 30.0. The CMS ranges from 0 to 100, with 100 representing the best score.

Conservative treatment consists of daily specific postural exercises, active-assisted motion, active training of scapular muscles, active range of motion, and daily posterior and anterior stretching. Strengthening exercises are usually performed. Therapists are advised to perform mobilisation techniques. Patient education that explains the cause of the symptoms and the rehabilitation protocol is essential in conservative treatment of degenerative rotator cuff tears. Subacromial steroid infiltration is often used successfully, and nonsteroidal anti-inflammatory drugs (NSAID) are also effective in decreasing pain in conservative treatment.

Surgical procedures are reported in patients with full-thickness rotator cuff tears with good clinical results. Improvement in the Constant Murley score following surgical therapy ranges from 24.0 to 43.1.

There is much debate on how to perform a rotator cuff repair. Open as well as mini-open and arthroscopic techniques are described. A shift from open to arthroscopic surgery in the United States is described. A recent meta-analysis could not detect significant differences between the two techniques in terms of time of surgery and functional outcome. The literature describes a variety of retear rates following surgical rotator cuff repair, ranging from 0 to 94%. The spread in reported retear rates is most likely caused by different repair techniques.

The overlapping results of the described conservative and surgical treatment studies point to comparable outcomes after both treatment modalities. Scientific evidence on which treatment is superior is limited, as only two randomised controlled trials have compared the two modalities, presenting conflicting results. A study by Kukkonen et al. found no difference between the two treatment modalities, and in a study by Moosmayer et al. surgical repair was favourable. It is therefore questionable what the best treatment for degenerative rotator cuff tears is. In clinical practice this results in a substantial variation between orthopaedic surgeons in terms of the chosen approach, as shown in a survey study by Dunn et al.
The radiological results of rotator cuff repair are partly dependent on whether the musculotendinous unit is elastic enough to allow lateralisation of the tendon to the footprint. Due to degenerative changes this elasticity diminishes. In advanced fatty infiltration the success of rotator cuff repair decreases, yet in conservative management increase in tear size and degeneration of the musculotendinous unit is of concern. Progression of a rotator cuff tear to an irreparable large tear and eventually cuff tear arthropathy remains challenging.

**AIMS**

The scope of this thesis is to optimise management of degenerative full-thickness rotator cuff tears. First objective is to determine whether there are differences in functional and radiological outcome between conservative and surgical treatment of degenerative rotator cuff tears. Second objective is to identify factors influencing the outcome of rotator cuff repair.

**OUTLINE OF THE THESIS**

The first aim is addressed in Chapters 2, 3 and 4. Chapter 2 describes the study protocol of a randomised controlled trial comparing surgical and conservative treatment of degenerative full-thickness rotator cuff tears. Chapter 3 presents the primary functional outcomes of this randomised controlled trial. Chapter 4 compares the radiological changes of conservatively versus surgically treated patients.

The second aim is addressed in Chapter 5, which presents the results of a systematic review for prognostic factors in rotator cuff repair. This review identifies prognostic factors for clinical outcome and cuff integrity following rotator cuff repair for full-thickness supraspinatus and infraspinatus tears.

Chapter 6 is the general discussion, which examines the results of this thesis within a broader perspective and gives recommendations for future research.
REFERENCES


