# Master's Thesis

**Danube University Krems**

# Additional Osteopathic Treatment as compared to Conventional Orthopaedic Therapy in Patients with Degenerative Complete Rupture of the Tendon of the Supraspinatus Muscle

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# ABSTRACT

This study examines patients with degenerative complete rupture of the tendon of the supraspinatus muscle. My research question is the following: **Is it possible to achieve better pain and shoulder function results in a patient group receiving osteopathic treatment in addition to conventional orthopaedic therapy than in a patient group only receiving conventional orthopaedic treatment?**

11 individuals of an experimental group and 11 individuals of a control group were examined according to exact inclusion and exclusion criteria to answer this question. The members of the experimental group received osteopathic treatment in addition to orthopaedic therapy.

The following five parameters (dependent variables) were used for evaluation of the therapeutic success: The patients had to indicate the intensity of their current pain on the 101-point visual analogue scale. The shoulder function was determined by evaluating active mobility in abduction, passive mobility in abduction with stabilisation of the scapula's inferior angle and passive mobility in abduction without stabilisation of the scapula's inferior angle, using a goniometer. As a fifth parameter, the practitioner evaluated the end-feel of passive abduction of the shoulder joint by using a 101-point numerical rate scale. The data of the two time points was statistically evaluated with the evaluative tool of repeated measures analysis of variance.

For the most part my hypothesis has been confirmed. In the parameters pain, active mobility in abduction, passive mobility in abduction with stabilisation of the scapula's inferior angle of the shoulder joint, as well as end-feel of abduction, the experimental group showed a better improvement than the control group. In passive abduction without stabilisation of the scapula of the shoulder joint no significant difference between experimental and control group was observed.

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# INTRODUCTION

Previous publications by De Seze, Ryckewaert, and Caroit (1963) on the frequency of rotator cuff tears have mistakenly given the impression that the rotator cuff tear is a kind of condition which is associated with increasing age and does not require any special treatment. In sections consisting of individuals of an average age of 77 years, they observed total tears of the rotator cuff in 66% and partial tears of the rotator cuff in 17% of the participants.

In the last decades this view has been contradicted by publications by Walch (1993) and Yamanada (1972). In a literature survey of a total of 1463 section findings an average of 12.9% showed total tears (Walch, 1993). In between 0 and 5% of the individuals who were younger than 40 years total tears were found (Yamanada, 1972).

Men are affected twice as often as women. In 69% of the cases the lesion is located on the dominant arm's side. In particular in severe tear forms, more than 50% of the patients are diagnosed with a rotator cuff tear in the second shoulder joint (Harryman, 1991).

About 50% of ruptures of the supraspinatus and infraspinatus tendons are due to atraumatic processes. In degenerative ruptures patients frequently suffer from an acute trauma which enhances the present defect and manifests itself as a clinical picture.

I believe that the fact that 13% of the population show complete ruptures at an age of about 60 years underlines the significance of conservative treatment for a large number of patients.

Three years ago I decided to cooperate with an orthopaedist in a common surgery. Among others I treat individuals who seek remedy for their shoulder problems.

I very soon found out how many patients seek medical advice due to pains and dysfunctions caused by complete ruptures of the tendon of the supraspinatus muscle. Thus I concluded that it would be beneficial to the occupational image of osteopaths in Austria for me to answer the following research question within the framework of my Master's thesis:

**Is it possible to achieve better pain and shoulder function results in a patient group affected by degenerative complete ruptures of the tendon of the supraspinatus muscle receiving osteopathic treatment in addition to conventional orthopaedic therapy than in a patient group only receiving conventional orthopaedic treatment?**

It is my objective to determine if a patient group receiving additional osteopathic treatment shows different results than a patient group receiving conventional orthopaedic therapy.
I chose the following five parameters to show the differences in pre- and post-treatment pain and shoulder function and illustrate my treatment results:

- The intensity of the current pain.
- The active mobility in abduction of the shoulder joint.
- The passive mobility in abduction of the shoulder joint with stabilisation of the inferior angle of the scapula.
- The passive mobility in abduction of the shoulder joint without stabilisation of the inferior angle of the scapula.
- The end-feel of abduction of the shoulder joint.

Chapter 3 (Method) explains how I used these five parameters to obtain my results.
In Chapter 4 (Results) I statistically evaluated my results to be able to illustrate the treatment results of both patient groups. In Chapter 2 (Anatomic and physiological background) I tried to convey some additional anatomic and physiological information going beyond the art's basic knowledge. This chapter also provides a more detailed description of the clinical picture of the degenerative complete rupture of the tendon of the supraspinatus muscle. Chapter 5 (Discussion) is a critical review of my entire study.
Thus, my **hypothesis** is the following: It is possible to achieve better treatment results in pain and shoulder function in a patient group with degenerative complete rupture of the supraspinatus muscle receiving osteopathic treatment in addition to conventional orthopaedic therapy than in patients only receiving conventional orthopaedic treatment.
I believe that it is very important for the recognition of osteopathy in Austria that osteopaths cooperate with doctors. Only this way can we communicate that our work also includes profound expertise in traditional medicine. We should be proud of our special skills and try to be a valuable addition to conservative therapy. Furthermore, we should not assume that doctors and experts from other occupational fields inform themselves about the work of osteopaths but since we have the ambition to achieve interdisciplinary cooperation, we should be taking the first step towards other occupational groups. We also need to be aware of the fact that our patients achieve the best progress in treatment when different occupational groups cooperate. Depending on their current state of health, patients need a

wide choice in different therapeutic measures. If we cooperate with doctors we gain credibility and respect.

I deeply hope that by writing my Master's thesis I succeeded in taking a step towards cooperation with other occupational groups.

# 2. ANATOMIC AND PHYSIOLOGICAL BACKGROUND

From the osteopathic point of view the shoulder consists of a joint complex comprising the following five joints:

- shoulder joint (glenohumeral joint)
- subacromial joint
- scapulothoracic joint
- acromioclavicular joint
- sternoclavicular joint

My personal presentation of the shoulder joint and the shoulder girdle is mainly based on Prof. Dr. med. Putz's view of this body part. Taking the anatomic expertise of osteopaths, physiotherapists and certainly doctors for granted I could elaborate important additional information without going beyond the scope of this thesis.

## 2.1. TOPOGRAPHIC AND FUNCTIONAL ANATOMY OF THE SHOULDER JOINT AND THE SHOULDER GIRDLE

### 2.1.1. Morphology and topography of the shoulder joint

The humeral head has an articular surface of about 24 cm² and a radius of about 2,5 cm (in the frontal plane), whereas the glenoid cavity's surface only amounts to about 6 cm². Compared to many other joints of the human body this difference in size of the two parts of the shoulder joint is highly remarkable. The adult humeral head is inclined to the humeral shaft axis at an angle of about 130° to 150° (Rockwood, 1990 and Huber, 1991). Conventional anatomic measurement methods show that the adult humeral head is torqued dorsally against the distal end of the humerus by an angle of about 30° to 45°. According to the art's literature this angle can vary greatly.
Recent research by Seggl et al. (1991) shows that five arterial vessels, linked through anastomoses and arising from the two humeral circumflex arteries, supply the proximal end of the humerus. However, for Gerber et al. (1990) the anterolateral branch of the anterior humeral circumflex artery is the most important branch for supplying the humeral head. They observed that the posterior humeral circumflex artery only supplies the greater tubercle and a small posteroinferior part of the humeral head.

In particular, the literature's data on the position of the glenoid cavity in relation to the scapula is quite varying. This is due to the art's insufficient consensus on the basis of measurement. Anetzberger and Putz (1994) illustrate that measurements have shown a largely constant tilt between the articular surface and the scapular spine's longitudinal axis. If measured in the scapula plane the tilt amounts to 90° (Anetzberger and Putz 1994). Assuming a neutral zero position (according to the Gerhardt and Russe SFTR method), it can be observed that the cartilage cover of the humeral head is thickest at the interface of humeral head and glenoid cavity. However, the thickness of the glenoid cavity's cartilage cover increases from the central towards the peripheral part and then passes into the glenoid labrum consisting of strong fibrous material (Saha, 1978).

In general, humeral head and glenoid cavity are not completely congruent, as demonstrated by the transversal cut or the CT image (Saha, 1978). Frequently, the anterior margin as well as the posterior margin of the glenoid cavity jut out significantly and probably rest on the thick cortical bone of the neck of the scapula. While the cartilage gets thicker towards its margins with a thickness of up to about 3 mm, the subchondral bone density of the glenoid cavity in elder people is highest in the central part and decreases towards the margins, as their glenoid cavity adapts to the permanent strain put on the joint (Müller-Gerbl, 1987).

The glenoid labrum, which is about 4 mm wide and equally thick, is principally composed of fascicles of dense collagen fibres, which concentrically embrace the glenoid cavity's margin. There are far less radial fascicles present. These guarantee the connection with the actual articular surface. Due to its structure the glenoid labrum may not be seen as an extension of the articular surface but as a counterforce against the considerable transverse extensions of the articular cartilage (Pauwels, 1965).

The labrum's attachment to the margin of the glenoid cavity varies considerably. Dorsally, radial fibres attach the labrum firmly and on a broad basis to the margin of the articular surface and the labrum rests directly on the hyaline cartilage cover. Ventrally, the fibrous ring is only loosely attached to the bone margin and spans the characteristic notch of its anterior margin. The loosest part of the labrum is situated along the inferior margin onto which the part of the joint capsule forming the axillary recess (Hertz et al., 1985) is attached.

The synovial membrane lies against the outer surface of the labrum and forms a circular furrow around it. The fibrous part of the joint capsule is referred to as fibrous membrane.

Where the fibrous membrane forms the ligaments, it is strongly interwoven with the labrum's outer margin. This is particularly true for the inferior glenohumeral ligament that fuses directly with the bone margin. On the medial side of the humeral neck the synovial membrane attaches a bit off the bone surface, whereby the axillary recess gets wider medialward (Hertz et al., 1985).

An arterial ring runs circularly along the glenoid labrum's basis. This ring is mainly supplied by the scapular circumflex artery from caudalward. The arterial ring anastomoses with the two humeral circumflex arteries.

### 2.1.2. Morphology and topography of the joint capsule

Dorsally, the joint capsule is very thin. Embracing the supraglenoid tubercle the joint capsule arises proximally from just outside the glenoid labrum and expands saccularly and ventrally into the subscapular muscle's bursa. It also embraces the two upper facets of the greater and lesser tubercles and runs to the bone-cartilage border of the humeral head. The joint capsule can be imagined as a limp sac with a volume of about 20 $cm^3$ (Cyprien, 1978). Contrary to the other large joints, the shoulder joint's capsule does not show any significant strengthening bands apart from the coracohumeral ligament.

The glenohumeral ligaments (superior, medial, inferior), which are highly variable, directed fibrous bands, are located on the joint capsule's front side. They are involved in the stabilisation of the joint in the end positions of external rotation and abduction (Cyprien, 1987).

The caudal part of the capsule, which in neutral zero position forms the axillary recess and is stretched in elevation, is by far more important. Cyprien et al. (1978) assume that the axillary recess plays an important role in the caudal stabilisation of the joint in the end position of abduction, as no supporting muscle tendon attaches to the capsule in this area.

The thickness of the joint capsule varies: Dorsally it is generally thinner than 1 mm. In the zone of the inferior glenohumeral ligament it is mostly 1 mm thick.

The coracohumeral ligament runs from the coracoid process lateralward into the joint capsule as a fibrous band and diverges towards the two tubercles. Superposing the bridge, it strengthens it across the intertubercular sulcus of the humerus (Mac Connail and Basmajian, 1981).

Near their insertion sites the tendons of the subscapular muscle, but also those of the supraspinatus, infraspinatus and the teres minor muscles firmly fuse with the joint capsule through their deeper fibres. Thereby the distal part of the joint capsule, with the exception of the axillary recess, runs into and continues as the various muscle tendons, which, within the capsule, are covered by the synovial membrane. The tendon of the long head of the biceps brachii muscle runs across the humeral head within the joint cavity. Between the tubercles the tendon inserts into the tight 2 to 5 cm long channel of the vagina synovialis intertubercularis (Mac Connail u. Basmajian, 1981).

A further ligament is the so-called intertubercular ligament: It results from the gathering of superficial fibres of the subscapular muscle's tendon, the lateralward running supraspinatus muscle's aponeurosis and the lateralward running infraspinatus muscle's aponeurosis. This intertubercular ligament runs lateralward across the intertubercular sulcus and forms a firm bandlike bridge. Thereby the fibrous bands of the so-called rotator cuff form a broad plate of connective tissue laterally around the humeral head (Mac Connail u. Basmajian, 1981). The proximal aperture of the so-called intertubercular channel exists in different forms. Usually the intertubercular ligament inserts along the sharp dorsalward directed edge of the tubercle. Together with this edge of the tubercle the ligament forms the topmost strengthening band of the joint capsule, the superior glenohumeral ligament. This superior glenohumeral ligament forms a reliable hypomochlion for the biceps tendon. Frequently, this aperture is funnel-shaped, whereby particularly in internal rotation and ventral elevation the tendon slides minimally distalward towards the edge of the lesser tubercle (Mac Connail and Basmajian, 1981).

### 2.1.3. Morphology and topography of the shoulder girdle

The bony elements of the shoulder girdle comprise the clavicle and the scapula. Interestingly, only the clavicle is directly connected with the thorax, namely through the sternoclavicular joint and the costoclavicular ligament.

Because of the movements the sternoclavicular joint is able to perform, it can be classified as a ball-and-socket-joint. This is due to the formability and structure of the articular disc, despite its saddle-shaped articular surface covered with fibrocartilage. The anterior and posterior sternoclavicular ligaments fuse with the disc through their internal fibrous bands, so that medialward directed shear forces can be absorbed in the axis of the clavicle. The sternal extremity of the clavicle seems to be carried by a ligament loop (Putz, 1986).

The interclavicular ligament and the costoclavicular ligament are additional safeguards, limiting the excursion in lifting and lowering. In elevation of the shoulder or in abduction of the shoulder joint, the clavicle of the sternoclavicular joint can be turned around a sagittal axis by about 45° in the frontal plane. In the transversal plane it can be turned ventralward by an angle of about 30° and dorsalward by about 30°. In the utmost extension of the arm the clavicle rotates around its longitudinal axis by about 45° (Putz, 1986).

The acromioclavicular joint has fibrocartilaginous, plane surfaces, which are directed strictly sagittally. They are separated by an articular disc which is fused with the superior and inferior acromioclavicular ligaments that strengthen the capsule.

Another ligament is the coracoclavicular ligament, consisting of the conoid and the trapezoid ligaments. Despite the considerable restriction of motion due to these two fibrous parts of the coracoclavicular ligament, the acromioclavicular joint is also a ball-and-socket joint. The scapula follows the excursion of the shoulder and/or the arm. The largest range of motion is possible in the rotation around the clavicle's longitudinal axis (Weinstabl et al., 1985).

In the frontal plane the coracoid process and the acromion are excessively strained in flexion. That's why they are connected by tendons and aponeuroses that confer to the scapula its shape of a framework construction with bands that are resistant to tensile forces. Due to the essential functions it performs, the coracoacromial ligament is particularly important. It is a mutual, dynamic band for the laterally protruding coracoid process and acromion. The band arises from the inferior surface and the anterior part of the acromion's inferior edge and runs along a gentle arch towards the dorsal surface of the coracoid process. There it attaches on a broad basis and proceeds as a cap-like insertion of the tendon of the pectoralis minor muscle (Putz et al., 1988).

The coracoacromial ligament proceeds medialward in the form of an aponeurosis, spanning the supraspinatous fossa and running from the scapular spine to the scapula's superior margin.

Together with the shovel-like inferior surface of the acromion and the inferior margin of the coracoid process the coracoacromial ligament forms the so-called fornix humeri. The areolar connective tissue and the subacromial bursa connect this vaulted roofing with the capsule of the shoulder joint. The fornix humeri provides the deltoid muscle, the coracobrachialis muscle and the short head of the biceps brachii muscle with more favourable moment arms. It also offers protection against a cranialward shifting of the humeral head.

All superior tendon parts of the rotator cuff are located underneath this roofing. Towards the coracoid process the available space is narrower than dorsally (Putz, 1986).

From a clinical point of view the <u>superior transverse scapular ligament</u> is very important. It runs from the coracoid process medialward towards the superior margin and converts the scapular notch into a tight channel. The suprascapular nerve passes through this notch. However, the suprascapular artery passes above the band.

The inferior transverse scapular ligament runs from the acromion towards the joint's edge. It covers the suprascapular nerve and artery.

The <u>scapulothoracic junction</u> is formed by two spaces of connective tissue. These are completely separated by the anterior serratus muscle. The space located medially from the muscle opens up cranial- and caudalward and contains only single lateral branches of the intercostal nerves and intercostal vessels, which run along the medial margin of the scapula towards the surface (Putz, 1986).

The space between the anterior serratus muscle and the subscapular muscle opens up downward as well as forward towards the axilla. In this anterior zone the thoracodorsal nerve running towards the latissimus dorsi muscle and the thoracodorsal artery can be found. The long thoracic nerve on its path towards the anterior serratus muscle is located just a bit ventrally thereof and the thoracoepigastric vein is located even more ventrally thereof.

In a relaxed upright posture the surface of the scapula is inclined at an angle of about 30° to the frontal surface. The medial margin is located two to three fingerbreadths off the spinous process line, and the superior angle is located on a level with the second rib.

Thus, the clavicle turns into the transversal plane, ascending outward at an angle of up to 5°. A lower located clavicle may be the cause of constriction of the costoclavicular space (Putz, 1986).

### 2.1.4. The supraspinatus muscle

The supraspinatus muscle is situated within the supraspinatous fossa. It originates from the middle two thirds of the bony walls of the fossa and from the supraspinatous fascia covering the supraspinatus muscle. This muscle develops a tendon towards which the muscle's fibres converge from all sides. On its path towards the insertion site in the uppermost zone, which is also referred to as the uppermost facet of the greater tubercle, the supraspinatus muscle also runs into the capsule of the shoulder joint (Netter, 1992).

Its nerve supply is effected by the suprascapular nerve. This nerve arises from the superior trunk of the brachial plexus and passes through the scapular notch into the supraspinatous fossa. Then it runs underneath the transverse scapular ligament towards the muscle's lower surface in order to supply the muscle together with the suprascapular artery running above the ligament (Netter, 1992). The suprascapular artery arises from the thyrocervical trunk of the subclavian artery. A hypovascular zone, which is also referred to as critical zone, is located proximally to the attachment site of the supraspinatus muscle's tendon (see Chapter 2.2.2. Intrinsic tendinopathies).

The functions of the supraspinatus muscle:

- In abduction of the shoulder joint the supraspinatus muscle is one of those muscles controlling the scapula's movements around the three spatial axes.
- Along with the deltoid muscle the supraspinatus muscle is one of the most important abductor muscles in the shoulder joint.
- The supraspinatus muscle counteracts the cranial displacement of the humeral head on the glenoid cavity in the course of abduction (Putz, 1986).

### 2.1.5. Functional anatomy of the shoulder

#### 2.1.5.1. Kinematics of the shoulder

Apart from a minor excursion from the neutral zero position, almost all movements represent a series of movements as an interplay of all joints of the shoulder girdle and the scapulothoracic junction.

In rotation the shoulder joint is most autonomous. Russe (1982) and Debrunner (1982) assume that the scapula is not lifted from the thoracic wall until the final phase of internal rotation and that increased pressure is not applied to the scapulothoracic junction until the final phase of external rotation.

In motion in the sagittal plane the scapula is displaced ventralward for flexion from about 45°, however, the scapula already moves dorsalward along with the motion from the neutral zero position (Russe et al. 1982).

The scapula's synkinesis was best analysed in abduction. The scapula and the shoulder joint perform the entire elevation process together. In the first phase (0 to 30°) the series of movements in the shoulder joint is most important (Inman, 1948 and Poppen, 1976). Inman (1948) and Laumann (1985) describe the scapula's minor motions of positioning and adjusting in that phase. In the further abduction the humerus and the scapula move at a ratio of 2:1 (Cochran, 1988). The shoulder joint alone allows an abduction of 120°, the scapula, along with the shoulder girdle, contributes a further 60°.

Using stereophotogrammetric analysis, Laumann (1988, 1978) could demonstrate that in elevation not only additional displacements occur, but that the scapula moves around the three spatial axes. Just a few, according to Laumann essential muscles control this series of movements. These are the clavicular and the acromial parts of the deltoid muscle, the descending part of the trapezius muscle, the supraspinatus muscle and the lower part of the anterior serratus muscle. According to Laumann (1985) the dysfunction of just one of these muscles leads to a severe dysfunction of the scapulothoracic rhythm even though this is a dysfunction that can be compensated for. If two of the essential muscles have failed, the affected shoulder joint suffers from a serious functional loss.

The scapula's flexibility on the thorax corresponds to the flexibility of the acromioclavicular and the sternoclavicular joints. In abduction the sternoclavicular joint moves along up to about 35°, the acromioclavicular follows up to about 25° (Cochran, 1988). The coracoclavicular ligament's parts restrict the relative movements between clavicle and scapula and only remain relaxed in adduction.

Kummer (1986) and Perry (1988) assume that in abduction/ adduction as well as in rotation of the shoulder joint the axes are displaced by up to 5 mm. This indicates that rolling and gliding mechanisms occur in the afore-mentioned motions.

### 2.1.5.2. Statics of the shoulder

Only with their tone the muscles attaching to the scapula hold the scapula against the thoracic wall. Even minor dysfunctions of these multidirectional muscular bands can lead to protrusion of the scapula's medial margin. This is called Scapula alata. The displacement of the scapula is also carried out by these muscular bands, the individual parts of which interact synergistically depending on the motion's direction and range (Putz, 1986).

In many arm actions the scapula's synkinesis creates space for the upward extension of the range of motion of the humerus and thus leads to a more favourable position of the glenoid cavity regarding the resulting force. However, it allows optimal transmission of the compressive stresses, increased in an abducted arm, onto the thorax. The trapezius muscle and, to a minor extent, the sternocleidomastoid muscle and the levator scapulae muscle assume the role of keeping the shoulder girdle in a cranial position. The anterior component of the centralward directed force is transmitted across the acromioclavicular joint to the clavicle und further to the sternoclavicular joint. However, on the one hand the scapula is supported by the scapulothoracic joint and on the other hand it is carried by the loop system of the superficial back muscles and the anterior serratus muscle (Putz, 1986).

With increasing abduction and the associated extension of the moment arm, the forces that are transmitted from the scapula and clavicle onto the thorax increase.

The shoulder joint does not require any bands for maintaining the contact between the different joint elements. The transmission of compressive stresses is exclusively carried out by the muscles surrounding the joint. In the neutral zero position the resulting force is of a magnitude corresponding to the arm's weight and is normally directed towards the centre of the glenoid cavity. The muscle tone alone is sufficient to keep the humeral head in the cavity (Pauwels, 1965 and Kummer, 1986).

In abduction, especially if induced by the deltoid and supraspinatus muscles or in carrying weight, a torque develops which can only be balanced by sharply increasing the muscular force. A force develops that leads to a cranialward shift of the humeral head on the glenoid cavity towards the fornix humeri (Poppen, 1977 and Saha, 1971, 1978).

This is counteracted by the muscle parts of the so-called rotator cuff and the supraspinatus muscle that act like adductors. If the humeral head is generally located at too high a level or if the muscular balance in motion is disturbed, the fornix humeri can be urged to assume the role of a counterforce.

Even under normal conditions the greater tubercle slides below the lateral edge of the fornix in abduction, as demonstrated by Tillmann (1984). Thereby the tendon of the supraspinatus muscle may be put under considerable stress, leading to pains on the one hand and apparently causing degenerative changes of the tendon even resulting in its complete rupture on the other hand (Macnab, 1981 and Reichelt, 1981).

## 2.2. PATHOGENESIS OF ROTATOR CUFF TEARS

The functioning of the different structures of the shoulder joint can be impaired not only by injuries but also by secondary diseases. These are divided into changes that endogenously constitute a weakness in the joint complex on the one hand and development- or degeneration-related processes on the other. In many cases age-related degeneration, combined with overuse, results in functional impairment of the joint; however, this is rarely true for endogenous degeneration (Loehr and Uhthoff, 1990).

The subacromial space lies underneath the acromion and the coracoid process and is spanned by the coracohumeral ligament. The subacromial bursa is situated within this space, which inferiorly contacts the rotator cuff and the long biceps tendon linked to it. In addition to the muscles of the rotator cuff – that is, the supraspinatus muscle, the infraspinatus muscle, the teres minor and the subscapular muscle – and the long biceps tendon, the deltoid muscle also spans this space and produces a direct compressive force on either the humeral head or the glenoid cavity. Any disturbance of this balance immediately leads to disparity in the distribution of force and consequently to impairment of function (Howell and Galinat, 1988).

Uhthoff (1986) calls those causes extrinsic or secondary which originate outside the tendon of the rotator cuff. He refers to those ones that result from pathological changes of the tendon itself as intrinsic or primary tendinopathies.

In cases of conical constriction it is difficult to recognise a difference between secondary extrinsic and primary intrinsic changes in the initial stages; thus, the term impingement is frequently used as a general description and explanation. The term in itself is not a diagnosis; it merely refers to a compression of the rotator cuff underneath the coracoacromial arch.

### 2.2.1. Extrinsic tendinopathies

Meyer (1937) first introduced the concept of “wear and tear“. He claimed that degenerative changes in the rotator cuff are caused by the mere moving of the shoulder day by day and year after year. According to him, what counted was not the extent but the constant repetition of the motion. Meyer’s morphological description suggests that these changes originate in the soft tissues and are accompanied by a thinning out of the joint capsule and the subacromial bursa’s becoming thick and villous. The tendons are abraded and torn eventually.

Neer, in 1972, took up and further developed this concept. In his view, 95% of tears are caused by a pathogenetic mechanism as described by Meyer. Based on patient age and pathophysiological findings, he defined three stages:

**Stage 1:** Oedematous swelling with haemorrhage in the tendon, reversible clinical picture in young patients.

**Stage 2:** Fibrosis, tendonitis, thickening of tendon and bursa caused by repeated irritation in patients aged 25 to 40.

**Stage 3:** Chronic mechanical-inflammatory irritation leads to partial tendon rupture and further on to complete tendon rupture; radiography shows acromial and humeral sclerosis accompanied by osteophytosis. Patients are typically over 40 years of age (Neer, 1983).

### 2.2.2. Intrinsic tendinopathies

Intrinsic tendinopathies are degenerative changes which can affect any tendon, thus also the tendon of the rotator cuff. There are systemic diseases such as diabetes mellitus, chronic polyarthritis or renal osteopathies which lead to secondary changes in tendon tissues. Strictly speaking, however, these changes have to be classified as extrinsic tendinopathies, as we refer to intrinsic changes as those which affect exclusively the tendon tissue of the rotator cuff. Changes of the vascular situation of the rotator cuff, especially of that of the supraspinatus tendon, but also, for instance, physiological degeneration in aging are examples for intrinsic tendinopathies.

Codman (1934) is a pioneer in research into the pathophysiology of the shoulder joint and of the rotator cuff. He first proved that most complete ruptures, and also calcifying tendonitis, were found in an area approximately 0.5 to 1 cm proximal to the tendon attachment. Many researchers have since directed their attention to this so-called critical zone (see Chapter 2.1.4.).

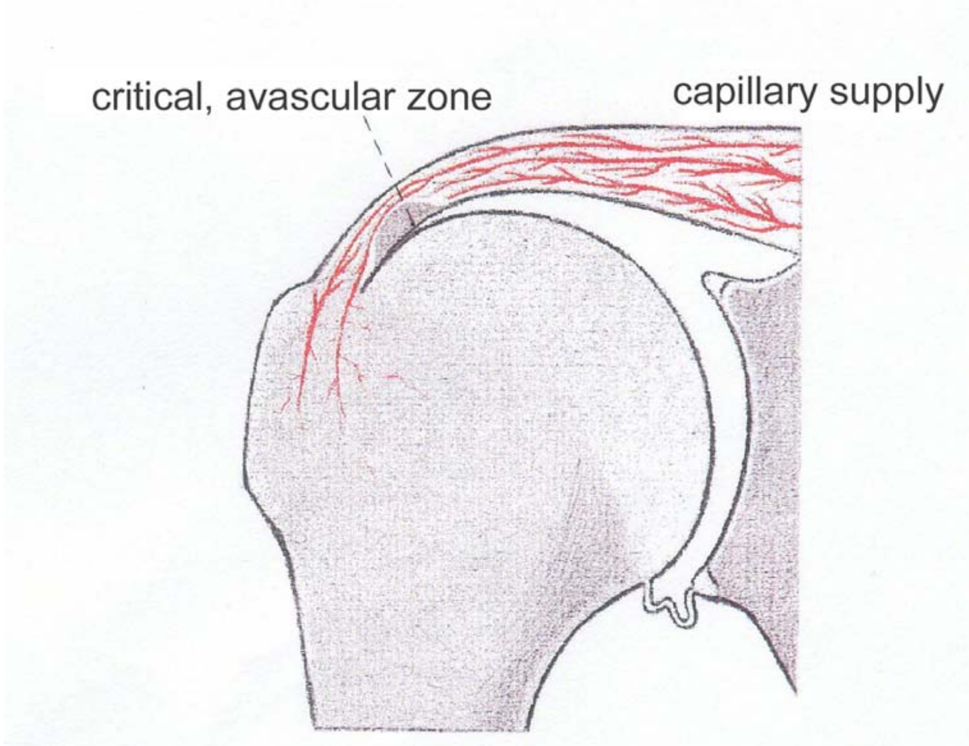


Figure 2.1.: Schematic representation of hypoperfusion in the tissue of the rotator cuff located on the joint side close to the bone attachment.

In their later works, Loehr and Uhthoff (1995) proved the existence of a zonal phenomenon concerning the bursal and the articular side. The articular side of the rotator cuff is disadvantaged as regards the vascular filling because it has a much lower amount of vascular channels running through the so-called critical zone than the bursal side; thus it is the articular side, not the bursal side, which suffers from hypoperfusion. Articular-side partial tears are most frequently found in this area.
Aging is described as a physiological as well as a pathological process. Yamanaka and Fukuda (1986, 1991) made an autopsy study in which they examined the age-related changes in the supraspinatus tendon. All age groups from the first up to the ninth decade of life were examined; however, as much as 89% were aged over 50. The results showed that 7.9% of the cases were complete ruptures, all of which were found in the critical zone.

It can thus be concluded that it is this area of the tendon attachment which is affected in the aging patient. The number of changes found in the proximal tendon like fatty degeneration and muscular atrophy, which are not necessarily age-related, varied.

### 2.2.3. Classification of rotator cuff tears by Neer and Poppen

Neer and Poppen (1987) define three groups of rotator cuff tears:

Group 1: In this group, which represents approximately 5% of tears, we find traumatic tears. Most patients are younger than 40. Isolated trauma is rarely observed.

Group 2: This kind of rotator cuff tear is caused by shoulder dislocation.

Group 3: These tears progress secondarily to a supraspinatus outlet syndrome.

The term supraspinatus outlet syndrome comprises and describes a subacromial impingement, or mechanical compression, as well as a functional reduction of the subacromial space accompanied by restriction of motion (Neer and Poppen, 1987). The majority of degenerative rotator cuff tears is attributed to the third group. In the initial stage they can be subdivided into three types of incomplete tears, that is, acromial-side tears, intratendinous tears and joint-side tears.

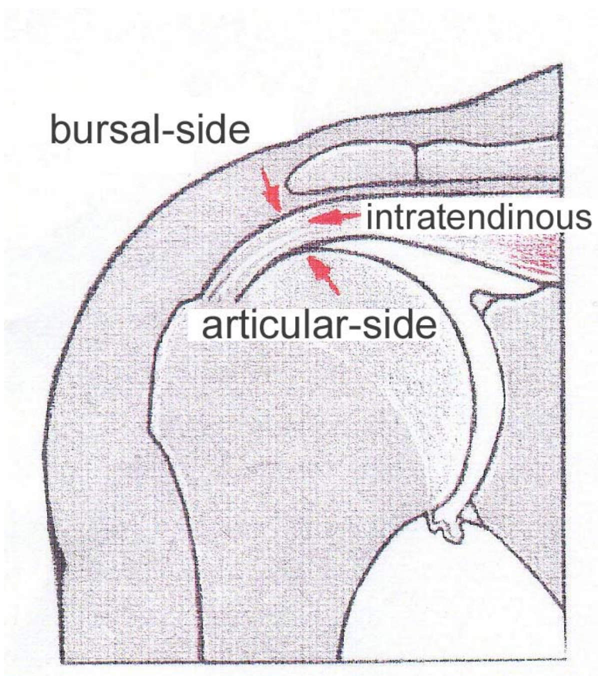


Figure 2.2.: A distinction is made between three types of partial tears: articular-side tears, bursal-side tears and intratendinous tears.

These initially incomplete tears may progress to complete tears and result eventually, in some cases, in defect arthropathy or in cuff arthropathy.
Cuff arthropathy is the complete loss of the rotator cuff combined with instability and progressive destruction of the glenohumeral joint (Neviaser, 1994).
Articular-side tears are additionally favoured by intrinsic changes, which are described in Chapter 2.2.2. The area of hypovascularity, the critical zone, promotes the aging process of the tendon.

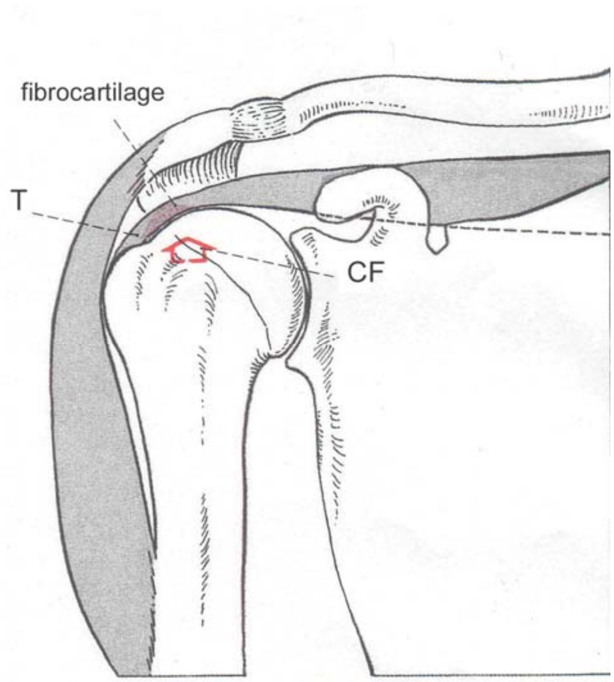


Figure 2.3.: Pathogenesis of the articular-side tendon rupture.
T = traction, CF = compressive forces

Based on collagen studies, Hamada and Okawara (1994) demonstrated that intrinsic reparative processes of rotator cuff tears are initiated; however, traction on the tendon inhibits restitution. Pathomechanics of the rotator cuff tear suggests that, in spite of the elevation of the tendon attachment by the greater tubercle, rerouting of the tendon is still necessary, especially in internal rotation and adduction movements. Counteracting the cranially-directed force of the deltoid muscle requires tensing the rotator cuff muscles, especially the supraspinatus muscle for maintaining the humeral head centred in the glenoid cavity during rotation and abduction movements.

According to Loehr and Helmig (1994), the arrangement of the muscles of the rotator cuff is scissor-shaped, thus centring the humeral head inside the glenoid cavity. The rotator cuff consists of the subscapular, infraspinatus, teres minor and supraspinatus muscles. The supraspinatus muscle exercises a depressor force on the articular condyle, thus centring it within the cavity. The rotator cuff can be seen as a tendinous extension of the glenoid cavity.

Tears of the rotator cuff are accompanied by a considerable loss of power. In abduction in the frontal plane the deltoid muscle exercises 50%, the supraspinatus muscle 35% and the long head of the biceps 15% of the force. Tears of the rotator cuff result in a loss of power of 62% in anteversion, 60% in external rotation and 46% in abduction (Habermeyer and Wiedemann, 1990).

A question of interest is whether rotator cuff tears are generally progressive or whether reparative tissue processes can halt their progression or even heal the lesion. Only few examinations say anything about the healing potential of the rotator cuff. The central question is which structures can provide the collagen required for tendon healing and by which means the tissue can be supplied with it during these reparative processes.

Examinations of the curing behaviour of flexor tendons in the hand have shown time and again that adhesion plays a major role in this process. This means that tendon healing is favoured by extrinsic factors, that is, the tendon sheath (Manske, 1988). The tendon sheath provides both the vascular component and the cellular elements required for growth of granulation tissue and further consolidation.

The rotator cuff, too, has this intrinsic healing potential, which can be demonstrated impressively after surgical removal of calcification in cases of calcifying tendonitis (Uhthoff, Sarkar, 1990). However, there is no such evidence for the curing of rotator cuff tears.

Uhthoff and Sarkar (1990) could trace granulation tissue in histological preparations which originates in the articular layers of the overlying subacromial bursa and which can form a cellular granulation cap on the stump. No vascularity is observed at the top of the typically flattened fibrous cap of the tissue. Swiontkoxski et al. (1990), carrying out in-vivo assays by means of laser Doppler studies, observed increased perfusion of the aponeurosis in patients suffering from a rotator cuff tear; from this phenomenon they deduced intrinsic curing efforts of the rotator cuff.

As already mentioned, the tendon is subject to constant traction; the fibres that are closer to the joint are, due to a shorter moment arm, subject to a higher strain rate, and they are at disadvantage in terms of vascularity. This permanent retraction is probably one of the reasons for the tendon's incapacity of restitution. Nakajima et al. (1994) examined in bodies the histological and biomechanical properties of the supraspinatus tendon and found out that in an area of up to 7 mm the bursal-side fibres were much stronger developed than the ones on the joint-side layer. A difference in elasticity of bursal-side and joint-side fibres was also observed. This is most probably the cause of articular-side tears as well as of interlaminar or intratendinous fissures between these two layers.
Ontogenetic findings in our own preparations show that the tendon attachments of the rotator cuff are already completely developed at a gestational age of a mere eight weeks. High variability was observed in the connection of joint capsule and inserting supraspinatus tendon.

### 2.2.4. Clinical picture of rotator cuff tears

Rotator cuff tears are most commonly observed in elderly people. They frequently result from degenerative changes. Many patients report that a fall on the extended arm caused the tear, or they start to feel pain during activities they are not used to or during sudden, uncoordinated movements. Upon further inquiry, however, it frequently turns out that they have a history of slowly increasing, undefined discomforts in the range of motion of the "painful arc" over a longer period (Habermeyer, 1996).
A "subacromial painful arc" may be felt in arm elevation between 60° and 120°. In the test the patient is asked to slowly elevate the arm from the zero position. If pain on motion occurs between 60° and 120° we speak of a painful arc. The structures situated between humeral head and acromion, as well as humeral head and acromion themselves, are the only structures that may produce such symptoms (Nicht operative Orthopädie und Manualtherapie, 1994).
In many cases atrophies of the supraspinatus and infraspinatus muscles are already existent; sometimes they are even accompanied by ruptures of the long biceps tendon. In people engaged in hard manual labour rotator cuff tears are observed more often in the shoulder of the dominant arm. In younger people rotator cuff tears are rarely observed; younger people are more likely to suffer from bony avulsions at the cranial pole of the greater tubercle

combined with formation of a haematoma. Rotator cuff tears may also evolve from shoulder dislocation.

Habermeyer (1996) identifies the following clinical parameters of the typical picture of a rotator cuff tear and thus also of a complete rupture of the supraspinatus tendon:

- Capability of free passive movement of the shoulder in most cases.
- Rotational movements cause a sensation of crepitation.
- Active movements frequently involve a "painful arc" or
- lead to pseudoparalysis: Active elevation of the arm causes problems; the arm can only be kept in a horizontal position for a short time.
- Patients try to evade the pain: In order to avoid painful movements they elevate the arm preferably in adduction or anteversion, or they perform screwing movements.
- In almost all cases abduction movements and, frequently, external rotation of the shoulder joint against a force cause pain and weakness.
- Positive supraspinatus test:

<u>Jobe 90-degree supraspinatus test:</u> The function of the supraspinatus tendon is tested. The patient maintains his or her arm extended in 90° abduction and 30° horizontal adduction (in the scapula plane) and internal rotation (thumb pointing downward). The examiner exercises downward force on the upper arm. The patient should be able to counteract the force.

In testing the ventral parts of the rotator cuff, the starting position is the same but the arm rotates externally. If the patient is not capable of counteracting gravity with the abducted arm, then this is referred to as a positive <u>drop-arm sign</u>.

- A positive <u>Neer impingement sign</u> is also observed: Standing behind the patient, the examiner stabilises the scapula with one hand while the other hand carefully leads the patient's arm into flexion and internal rotation and thus provokes a painful choke of the greater tubercle and the fornix humeri.

In abduction, external rotation can release the greater tubercle from the subacromial conflict by performing a screwing movement.

- After injection of a local anaesthetic in the subacromial space, the supraspinatus test and the Neer impingement sign are negative. However, weakness in arm motion persists; differential diagnosis suggests that this may be a sign of tendinopathy.

Arthrography of the shoulder joint, positive sonographic results or convincing MRI confirms the clinical picture.

Partial tears of the rotator cuff can have the same symptoms as complete tears. However, diagnosis of a partial tear is more difficult. Depending on the location of a partial tear (articular side, intratendinous or bursal side), arthroscopy, arthrography, sonography or MRI is indicated.

## 2.3. DEFINITION OF OSTEOPATHY

Numerous osteopaths have defined osteopathy as a method of treatment based on a holistic concept.

“Osteopathic medicine is a philosophy, a science, and an art. Its philosophy embraces the concept of unity of body, structure, and function in health and disease. Its science includes the clinical, physical, and biological sciences related to the maintenance of health and the prevention, cure, and alleviation of disease. Its art is the application of the philosophy and the science in the practice of osteopathic medicine and surgery in all its branches and specialties.” (Wright, 1976, S.7)

I would like to illustrate the six principles of osteopathic medicine with the help of definitions by renowned osteopaths.

Upledger (2002) discusses the basic premise of osteopathy: **Life is movement.** Upledger follows the assumption that everything in the universe is in motion, humans being no exception to this rule. Bones, articulations, muscles, and viscera, which ensure the functioning of the whole, are indispensable for the humans’ ability to move. Upledger further considers rhythm, exchange, constant adaptation, and defence, integral elements of the principle “life is movement”.

**A further principle of osteopathy is the following: The body is self-healing.** Upledger (2002) believes that osteopathy is the art to activate the body’s self-regulating mechanisms. He suggests that osteopaths should examine the sequences of movements and exchange processes in order to identify and eliminate sources of irritation. This principle is true for all movements from the very small to the very big.

Billions of small movements form a whole, a functional unit. **With this statement, Upledger underlines a further principle of osteopathy, namely the principle that each**

**lesion affects the whole body.** As our bodies are one functional unit, every lesion leads to a disruption of the whole.

**The structure controls the function, whereas, at the same time, the function has an influence on the structure.** Liem (1998) emphasises that the interdependency between the structure of the body, i.e. the anatomy, and its function, i.e. physiology, form the basis for diagnosis and therapy. His concept of structure includes bony, muscular, fascial, visceral, and neural parts of the body as well as body fluids. It is further based on the assumption that each person's particular physical structure determines their capabilities and functional abilities. Certain functions on the other hand lead to changes in this structure – changes which are indispensable for an optimum performance of this same function.

**The rule of the artery constitutes a further principle of osteopathy.** By establishing the rule of the artery, A.T. Still postulated that free flowing blood ensures health, whereas local or general circulatory problems can be cause for disease. Everything alive flows. When a body fluid (such as arterial blood, venous blood, lymph, as well as synovial, cerebrospinal, pericardial and follicular fluids) is hindered in its flow, an obstruction occurs. As a consequence, the nerve supply of tissue can be impaired, hence causing reduced oxygen and nutrient supply as well as a reduced decrease of metabolites in the tissue, which finally results in the tissues losing vitality. (Liem T., Kraniosacrale Osteopathie, 1998, pages 4-5).

**The path of least resistance forms the sixth principle of osteopathy.**

## 2.4. CURRENT STATE OF RESEARCH

When searching for other theses dealing with the topic of "Additional Osteopathic Treatment as compared to Conventional Orthopaedic Therapy in Patients with Degenerative Complete Rupture of the Tendon of the Supraspinatus Muscle" I discovered that this topic had not yet been approached in a Master's thesis.

In 2004, P. Fichtinger wrote her Master's thesis at the school of physiotherapy (Akademie für Physiotherapie) in Steyr, Austria, on the rupture of the supraspinatus tendon regarding the differences between operative and conservative treatment taking into consideration flexibility, pain and function of the respective limb and foci of physiotherapeutic treatment. Fichtinger was first to formulate the hypothesis that there is no difference in the healing process of patients after the rupture of the supraspinatus tendon regarding flexibility, pain and function of the respective limb between patients undergoing operative treatment and those undergoing conservative treatment.

Her second hypothesis was that the foci of treatment of patients who were treated operatively and those who received conservative treatment after the rupture of their supraspinatus tendon were the same.

The first part of the thesis consisted of a literature survey. As this thesis covered a completely different topic, Fichtinger’s hypothesis was of little interest to me. It was the second part of the thesis which was of greater importance to my research. In this part, a test was carried out with two groups of patients with the help of the acknowledged Constant-Murley Shoulder Outcome Score. The first test group consisted of five operated patients; the second test group of five conservatively treated patients. The shoulder score was measured at three different sessions: preoperatively/ before physiotherapeutic primary treatment; five weeks after the operation/ the primary treatment; twelve weeks after the operation/ the primary treatment.

This clinical score assesses the patient’s shoulder subjectively (35%) and objectively (65%). The patients were actively tested according to the score criteria, asked related questions and allocated corresponding points. The results, showing pain, function, and flexibility, were displayed on an x-/y-diagram.

If Fichtinger’s thesis had covered a greater number of participants, the result would have been even more meaningful. However, the author’s use of Constant and Murley’s Shoulder Outcome Score was of great benefit for the study, as this allows for a repetition and reproduction of the study. The third measurement 12 weeks after the operation/ the last treatment was of particular interest as it showed – which will be noted especially by osteopaths – that patients improve considerably even after the last treatment.

In 2002, A. Moser wrote a Master’s thesis at the school of physiotherapy (Akademie für Physiotherapie) in Salzburg, on conservative versus operative treatment of subacromial impingement syndrome of the shoulder. The author’s focus was on the research question whether in physiotherapy it is possible to use conservative treatment, thus preventing operation.

The special interest in this thesis lies in that the author narrowed down the meaning of the term impingement of the shoulder to rotator cuff tears. His research methods included a literature survey followed by expert interviews with physiotherapists and physicians (trauma surgeons). The literature survey showed that the conservative treatment of complete tears of the rotator cuff with a chance of recovery of 40% is considerably less successful than operative therapy with 71 to 84%. The expert interviews, which consisted of five questions to each of the physiotherapists and physicians, showed the following result: The decision on whether a patient is to be treated purely conservatively or operatively differs from patient to patient. Treatment is chosen according to the patient's subjective sensation of pain, his or her professional and leisure activities, age, type (traumatic, degenerative) and size of the tear. This shows that the author's hypothesis was only partly correct. However, the significant conclusion of his thesis was that in general there is no contraindication to conservative treatment of patients with rotator cuff tears.

# 3. METHOD

## 3.1. THE STUDY

The type of study applied is a non-randomised clinical study. The exact term is non-randomised matched (match controlled) study. Although randomisation is known to be the key element of an experimental study (Ernst, 2004), in my clinical study pre-randomisation was not possible due to time pressure and too small a number of participants.
Thus it was very important to make sure that the characteristics of the patients in the experimental group and the control group match perfectly. Exact inclusion and exclusion criteria were defined for the selection of participants. With the help of an orthopaedist it was possible to enrol 22 patients who met all the inclusion criteria and who were thus suitable for treatment in the study. Without this orthopaedist's support I could not have come up with such a large number of participants within this short a period of time. Examination and treatment of the patients took place between January 4 and May 17, 2006.

## 3.2. PARTICIPANTS

### 3.2.1. Inclusion and exclusion criteria

In order to find suitable participants for the non-randomised study, I defined, in cooperation with an orthopaedist, certain inclusion and exclusion criteria in preparation of the study. In the following the participants are also referred to as patients because all the participants had consulted the orthopaedist due to pain or functional impairment of the shoulder joint.
The following inclusion criteria were defined:

- Patients have to be between 40 and 70 years of age.
- Patients have to display a complete tendon rupture of the supraspinatus muscle confirmed by ultrasound. This tendon rupture has to be degenerative.

The following exclusion criteria were defined:

- Patients are under 40 or over 70 years of age.
- Patients display a tendon rupture of the supraspinatus muscle caused by acute trauma.
- Patients display a tendon rupture of the supraspinatus muscle combined with shoulder dislocation.

- Patients with injuries for which orthodox medicine indicates immediate surgery.
- Patients who have previously undergone surgical interventions in the area of the shoulder joint.
- Patients with neurological diseases that change the muscle tone.

### 3.2.2. Number of participants

22 patients were enrolled in the non-randomised study between January 4 and May 17, 2006. During this period all of these participants were patients in the orthopaedist's surgery due to pain and functional impairment of the shoulder; they complied with all the inclusion criteria and agreed to participate in the study.
Those patients who were allocated to the experimental group, receiving osteopathic treatment, were not charged for this treatment.

## 3.3. PERFORMANCE OF THE MATCH CONTROLLED STUDY

### 3.3.1. Experimental group and control group

The group of patients was divided into an experimental group and a control group. In order to avoid deliberate allocation of a certain patient to a certain group, I allocated them alternately, in the order they came into the surgery, to the experimental group and the control group.
Experimental group:
Of the 11 patients allocated to the experimental group, each patient received a three-week conventional orthopaedic treatment and an additional osteopathic treatment.
On the first day, before the beginning of the treatment, I started with a thorough anamnesis of the patients and issued an initial report of findings. An initial report of findings was also issued with respect to the five parameters, also called dependent variables, by means of which I could measure the changes taking place in the course of the treatment.
Each patient of the experimental group received a three-week treatment in my surgery. During these three weeks they underwent the following orthopaedic and osteopathic treatments:

Each Wednesday: 1. Treatment with interference current
2. Ultrasound treatment

3. 45-minute osteopathic treatment

Each Friday 1. Treatment with interference current

2. Ultrasound treatment

3. Administration of a subacromial injection

On the last day, after the last session of treatment, I issued a final report of findings. Again I included an assessment of the five parameters (dependent variables).

Control group:

As in the experimental group, each of the 11 patients allocated to the control group received a three-week conventional orthopaedic treatment. However, the control group did not receive osteopathic treatment.

Here, too, I started with a thorough anamnesis and issued an initial report of findings on the first day of treatment. I also issued an initial report of findings with respect to the five parameters (dependent variables).

As in the experimental group, each patient of the control group received a three-week treatment in my surgery. During these three weeks the patients underwent the following orthopaedic treatments:

Each Wednesday: 1. Treatment with interference current

2. Ultrasound treatment

Each Friday: 1. Treatment with interference current

2. Ultrasound treatment

3. Administration of a subacromial injection

On the last day, after the last session of treatment, I issued a final report of findings. Again I included an assessment of the five parameters (dependent variables).

### 3.3.2. The five parameters (dependent variables) applied to evaluate the success of the treatment

The following research question was devised: Is it possible to achieve better pain and shoulder function results in a patient group receiving osteopathic treatment in addition to conventional orthopaedic therapy (experimental group) than in a patient group only receiving conventional orthopaedic treatment (control group)?

In order to be able to demonstrate the changes in pain intensity and shoulder function before and after treatment I defined the following five parameters (dependent variables):

**3.3.2.1. Evaluation of the intensity of the patient's current pain: 101-point visual analogue scale (VAS)**

I used a VAS similar to that of Scott and Huskisson, 1976 (Dos Winkel, page 52). This VAS consists of a horizontal line on which the patients indicate the intensity of their pain with a vertical dash.

In order to avoid confusion for the patient the line is placed in the centre of the VAS sheet. The only marks on the sheet are a dash each at the left and right end of the line; any further graduation of the line would decrease sensitivity. The line has a length of 10 cm; its left end is marked with "no pain" and its right end with "maximum pain".

The patients indicated the intensity of their current pain before the first session of treatment (first time point) and after the last session of treatment (second time point) by placing a vertical dash on the line. The patients were not shown their previous indication before making their second indication. The distance of the dash placed by the patients is measured in millimetres from the left end of the VAS.


Figure 3.1.: 101-point visual analogue scale

**The following four parameters were chosen for evaluation of the function of the shoulder joint:**

**3.3.2.2. Active mobility in abduction of the shoulder joint**

For evaluation of the range of motion in active abduction I applied the neutral zero position according to the Gerhardt and Russe SFTR method (sagittal, frontal, transversal plane and rotation) (Rens 1987, page18). I chose this anatomic posture (neutral zero position) as a starting position for the abduction movement. The patients were in an upright standing position during the test.

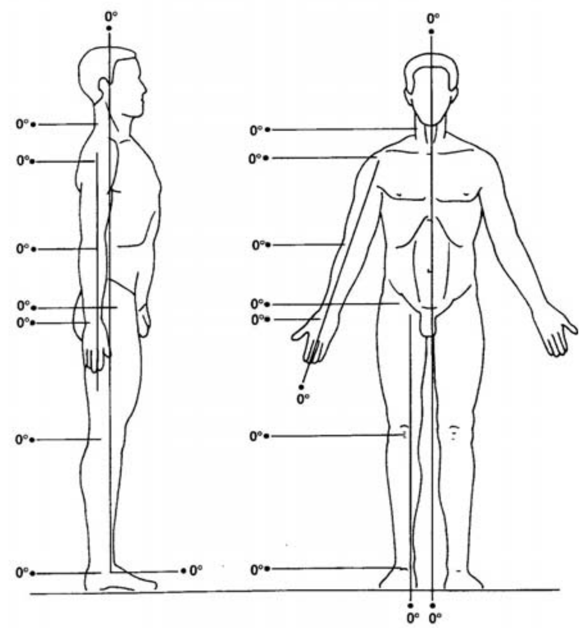

Figure 3.2.: Definition of the neutral zero position according to the SFTR method.

In the SFTR method each movement is performed in a specific plane. Abduction is performed in the frontal plane.

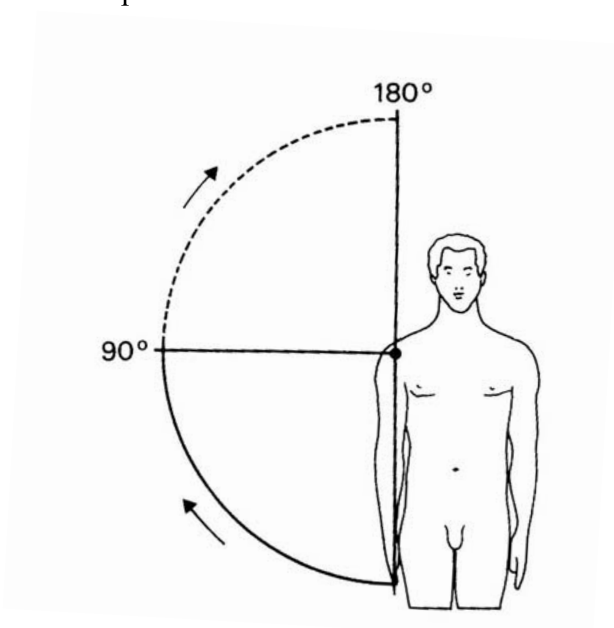


Figure 3.3.: Abduction in the frontal plane.

The range of motion was measured in degrees with a goniometer. A goniometer is a simple, inexpensive and very useful device. I used a transparent plastic goniometer. The centre of the goniometer was positioned above the greater tubercle with the fixed arm pointing vertically downward and the movable arm in a line with the longitudinal axis of the upper arm.

After the patients had adopted the posture described above, they were asked to move their arm actively in abduction as far as possible. In order to avoid evasive movements such as lateral inclination of the torso toward the opposite side, the patients were asked to simultaneously abduct their other arm (Dos Winkel, Nichtoperative Orthopädie und Manualtherapie, page 273).

In order to measure in degrees the maximum range of motion achieved in active abduction, the movable arm of the goniometer was placed in line with the patients' upper arm.

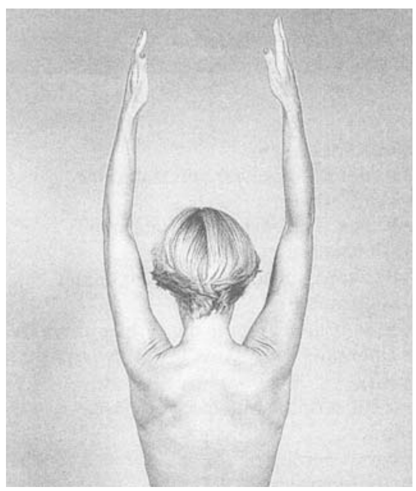

Figure 3.4.: Active abduction of the shoulder joint.

**3.3.2.3. Passive mobility in abduction of the shoulder joint with stabilisation of the inferior angle of the scapula**

In this test, too, I started from the neutral zero position according to the Gerhardt and Russe SFTR method (Rens 1987, page18) (see parameter 3.3.2.2.). Again, the patient was in an upright standing position.

The test was performed as follows: Standing behind the patient, my hand stabilised the inferior angle of the scapula. My thumb stabilised the lateral margin just above the inferior angle of the scapula.
My second hand encompassed the patient's elbow, which was flexed at 90°, the lower arm of the patient pointing forward. With this hand I moved the upper arm in abduction in the shoulder joint until the lateral margin of the scapula made contact with my thumb (Dos Winkel, Nichtoperative Orthopädie und Manualtherapie, page 280). In the meantime a second physiotherapist had put the goniometer in place (see parameter 3.3.2.2.) and then measured the range of passive abduction in degrees.
This test made it possible for me to examine passive abduction solely in the glenohumeral joint.

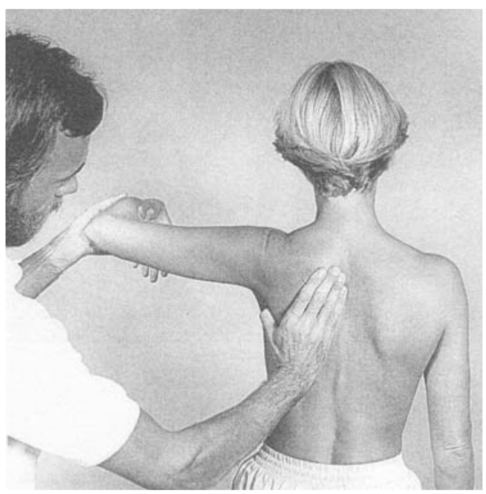

Figure 3.5.: Passive mobility in abduction of the shoulder joint with stabilisation of the inferior angle of the scapula.

### 3.3.2.4. Passive mobility in abduction of the shoulder joint without stabilisation of the inferior angle of the scapula

In this test, too, I started from the neutral zero position according to the Gerhardt and Russe SFTR method (Rens 1987, page18) (see parameter 3.3.2.2.). Again, the patient was in an upright standing position.
The test was performed as follows: Standing behind the patient, my hand now only rested on the posterior side of the shoulder, thus being able to assess the range of motion and the

end-feel of the whole shoulder girdle. Again, my second hand encompassed the patient's elbow, which was flexed at 90˚, and performed the abduction of the upper arm in the shoulder joint (Dos Winkel, Nichtoperative Orthopädie und Manualtherapie, page 278). In the meantime a second physiotherapist had put the goniometer in place (see parameter 3.3.2.2.) and then measured the range of passive abduction in degrees.

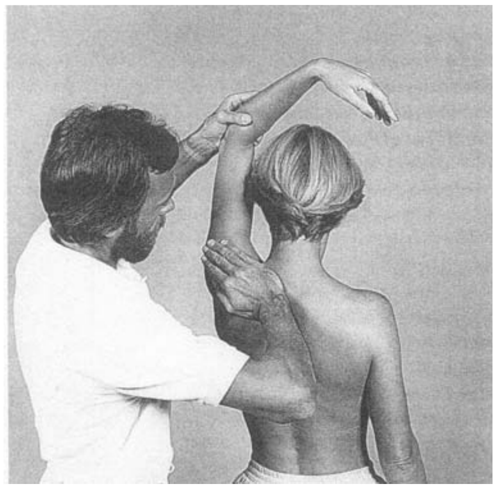

Figure 3.6.: Passive mobility in abduction of the shoulder joint without stabilisation of the inferior angle of the shoulder joint.

This test usually serves to assess the flexibility of the whole shoulder girdle. This gives us information on whether the reduced flexibility is a problem of the shoulder joint itself or whether it is, in fact, the result of a functional problem of a joint of the shoulder girdle other than the shoulder joint.

As already mentioned in Chapter 2 (Anatomic and physiological background), in osteopathy a lesion of any kind affects the system as a whole; especially lesions in the joints of the shoulder complex can lead to an imbalance of the entire system.

#### 3.3.2.5. Evaluation of the end-feel of abduction of the shoulder joint: 101-point numerical rate scale (NRS-101)

The neutral zero position according to the Gerhardt and Russe SFTR method (Rens 1987, page 18, see Chapter 3.3.2.2.) was used as a starting position for testing the end-feel of the abduction of the shoulder joint. The test was performed on the standing patient again.
As the examiner, I stood behind the patient. Again, my hand stabilised the inferior angle of the scapula by placing the thumb on the lateral margin just above the inferior angle. My second hand encompassed the patient’s elbow, which was flexed at 90˚, in order to move the arm passively in abduction. This time the abduction movement was performed a little more extensively than in testing passive abduction of the shoulder joint with stabilisation of the inferior angle (Dos Winkel: Nichtoperative Orthopädie und Manualtherapie, page 281).

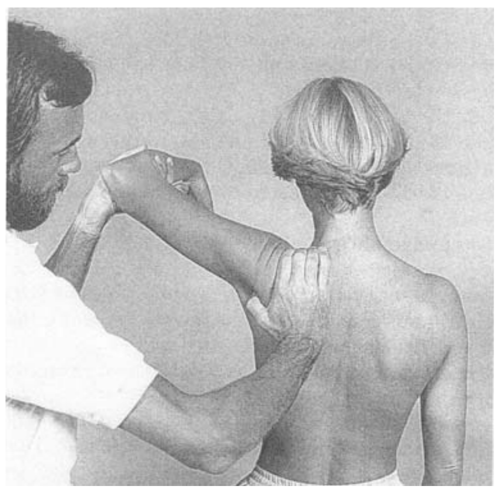

Figure 3.7.: End-feel of passive abduction of the shoulder joint.

I concentrated on the end-feel of the movement. For testing the end-feel of the abduction of the shoulder joint I used a 101-point numerical analogue scale (NRS-101). The advantage of the NRS-101 compared with a nominal scale is that in a nominal scale it is very often not clearly defined how terms like “hard-elastic” and “moderately elastic” relate to each other; in a quantitative scale, however, there is no doubt that “60” is higher than “50”.
Jensen tested the reliability and validity of the NRS-101 (Jensen et al.1986).
As in the VAS-101 point scale (see parameter 3.3.2.1.), I used a 10 cm horizontal line placed in the centre of the sheet. The left and the right end of the line are marked with a

short vertical dash. The left end of the line is marked with “maximum soft” and the right end of the line is marked with “maximum firm”. After testing the end-feel I indicated my perception of the end-feel by placing a vertical dash on the line. The distance between the left end of the line and my vertical dash was measured in millimetres. Thus I obtained a value for the end-feel before the start of the treatment (first time point) and another value for the end-feel after the last treatment (second time point).

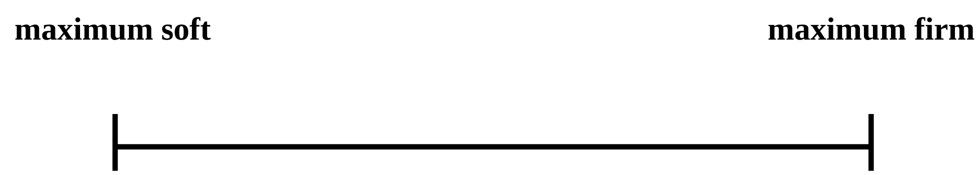


Figure 3.8.: 101-point numerical analogue scale.

## 3.4. FURTHER OSTEOPATHIC EXAMINATION AND TREATMENT OF THE PARTICIPANTS

Before the first session of treatment I started with a thorough anamnesis of the patients. After that I continued with the detailed testing of the parameters (dependent variables) described in Chapter 3.3.2. for evaluation of treatment success. In addition to these tests I conducted a general listening in order to obtain even more information on any possible dysfunction in the patient’s entire body. I also thoroughly examined all the joints of the shoulder girdle, the lower cervical spine, the superior thoracic aperture and the upper thoracic spine.

I treated the 11 patients of the experimental group osteopathically once a week over a period of three weeks. Each treatment lasted 45 minutes.

In these treatments I applied a lot of techniques from Stephen Typaldos’ fascial distortion model. It seems to me that during the initial phase of the treatment of patients with degenerative complete tendon rupture of the supraspinatus muscle the application of these techniques of Typaldos’ is most effective. Of course I also worked with a lot of Bernard Ligner’s joint mobilisations, joint corrections and soft tissue techniques. I also got into the habit of including the cervical fascia in the treatment; here I make frequent use of Torsten Liem’s craniosacral techniques and Jane E. Carreiro’s balanced ligamentous techniques.

The following was my impression of the treatments within this Master's thesis: At the beginning I achieved the greatest progress with Stephen Typaldos' techniques. However, the more I also included treatment of the other functional connections of the shoulder joints with the thorax, the thoracic spine, the cervical spine and, not to forget, the visceral organs, the more durable were the effects of the therapy.

## 3.5. STATISTICAL ANALYSIS

Data input and data processing was conducted on a personal computer with the help of SPSS 11.5. for Windows and Microsoft Excel.

For the evaluation I applied repeated measures analysis of variance (2 time points). Data on the individual participants was represented by means of descriptive statistics.

# 4. RESULTS

## 4.1. AGE OF PARTICIPANTS

This non-randomised study enrolled a total of 22 participants. The figure below shows the age distribution of the 22 participants:

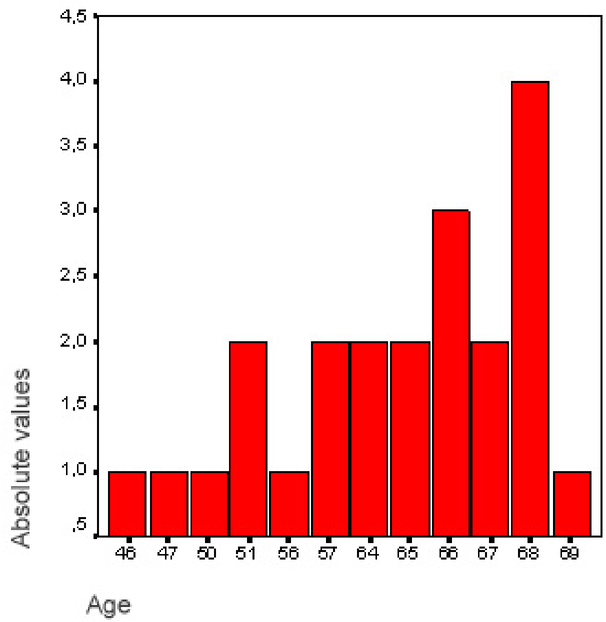


Figure 4.1.: Age distribution of participants

There was one representative each for the following ages: 46, 47, 50, 56 and 69. Two participants each were aged 51, 57, 64, 65, and 67; 3 patients were 66 and four patients were 68 years old.

**4.2. SEX OF PARTICIPANTS**

The figure below shows the ratio of male and female participants:

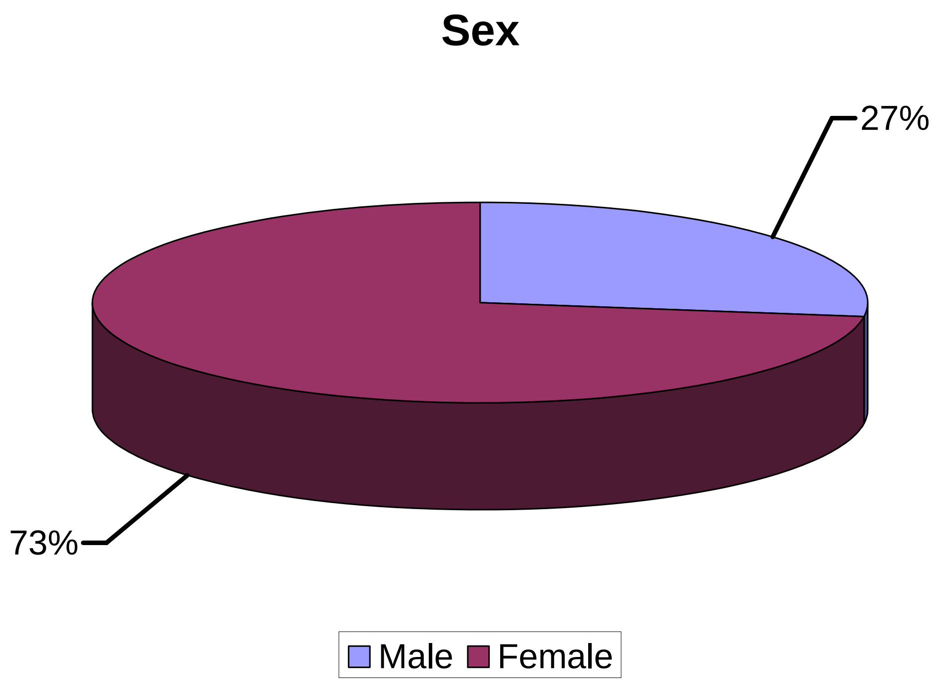


Figure 4.2.: Ratio of male and female participants

27 percent of the participants were male, 73 percent were female.

**4.3. RESULTS OF THE 101-POINT VISUAL ANALOGUE SCALE (VAS-101): MEASURING THE PATIENT'S CURRENT PAIN INTENSITY**

Analysis of variance with repeated measurements at $\alpha = 0.05$ was employed to examine whether there was a difference in the intensity of pain between the experimental and control groups from time point 1 to time point 2. Test statistical analysis reveals a significant time effect ($F = 184.834$; $p = 0.000$) and significant reciprocity (time*intervention) ($F = 59.431$; $p = 0.000$) between the experimental and control groups.

**Descriptive Statistics**

| | Group | Mean value | Standard deviation | N |
|---|---|---|---|---|
| **PAIN 1** | Experimental group | 61,36 | 14,881 | 11 |
| | Control group | 59,09 | 16,355 | 11 |
| | Total | 60,23 | 15,303 | 22 |
| **PAIN 2** | Experimental group | 17,27 | 14,867 | 11 |
| | Control group | 46,91 | 15,566 | 11 |
| | Total | 32,09 | 21,229 | 22 |

Table 4.1.: Descriptive statistics on pain intensity

N = sample size

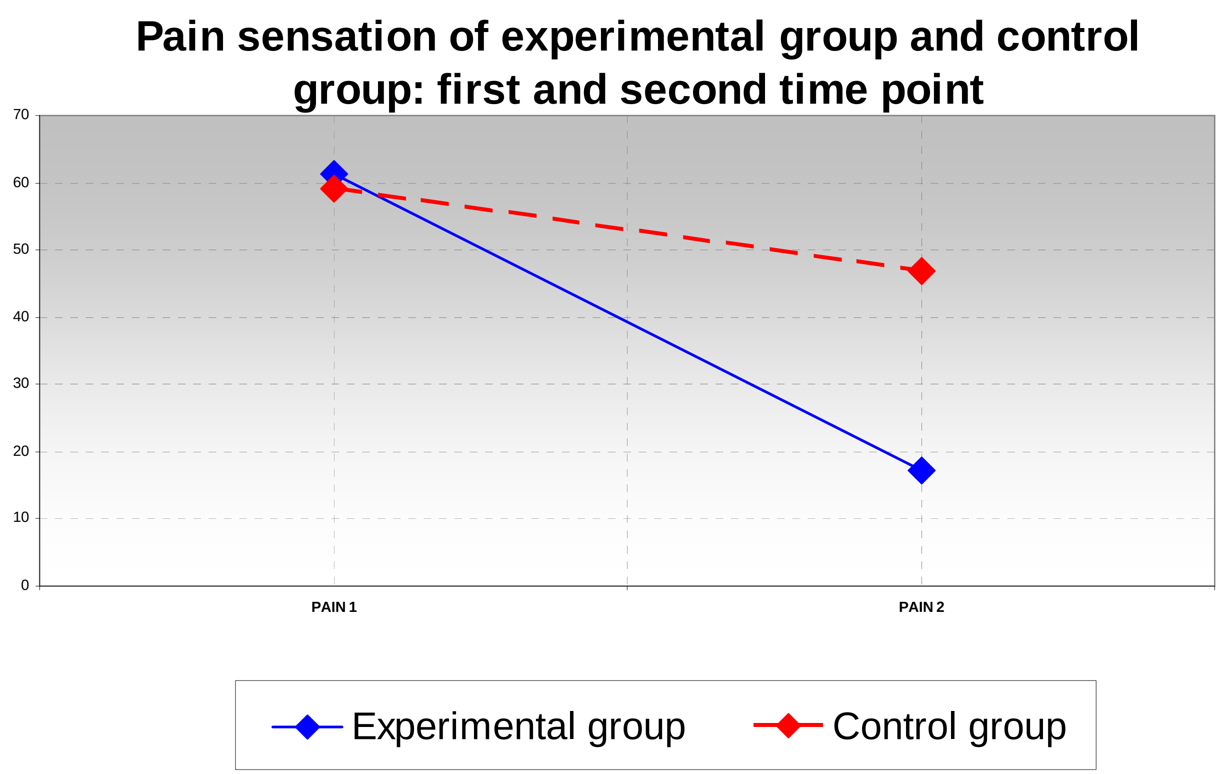


Figure 4.3.: Pain experienced by participants

PAIN1 specifies the mean value of current pain experienced by the experimental and the control group at the first time point (before the start of the treatment). PAIN2 specifies the mean value of the current pain experienced by the experimental and the control group at the second time point (after the last treatment).

The mean values for the 11 patients of the experimental group were 61.36 at the first time point and 17.27 at the second time point. The results demonstrated a significant reduction in pain from the first to the second measurement.

The control group results were as follows: The mean values for the 11 participants of the control group were 59.09 at the first time point and 46.91 at the second time point. Although this group also experienced a reduction in pain, it was not as significant as the one experienced by the experimental group.

## 4.4. RESULTS OF THE PARAMETER “ACTIVE MOBILITY IN ABDUCTION OF THE SHOULDER JOINT“

Analysis of variance with repeated measurements at $\alpha = 0.05$ was employed to examine whether there was a difference in the active mobility in abduction of the shoulder joint between the experimental and control groups from time point 1 to time point 2. Test statistical analysis reveals a significant time effect ($F = 23.737$; $p = 0.000$) and significant reciprocity (time*intervention) ($F = 3.470$; $p = 0.077$) between the experimental and control groups.

**Descriptive Statistics**

| | Group | Mean value | Standard deviation | N |
|---|---|---|---|---|
| **ACTMOB 1** | Experimental group | 143,18 | 27,228 | 11 |
| | Control group | 100,00 | 50,744 | 11 |
| | Total | 121,59 | 45,471 | 22 |
| **ACTMOB 2** | Experimental group | 164,55 | 15,725 | 11 |
| | Control group | 109,55 | 53,687 | 11 |
| | Total | 137,05 | 47,776 | 22 |

Table 4.2.: Descriptive statistics on active abduction

N = sample size

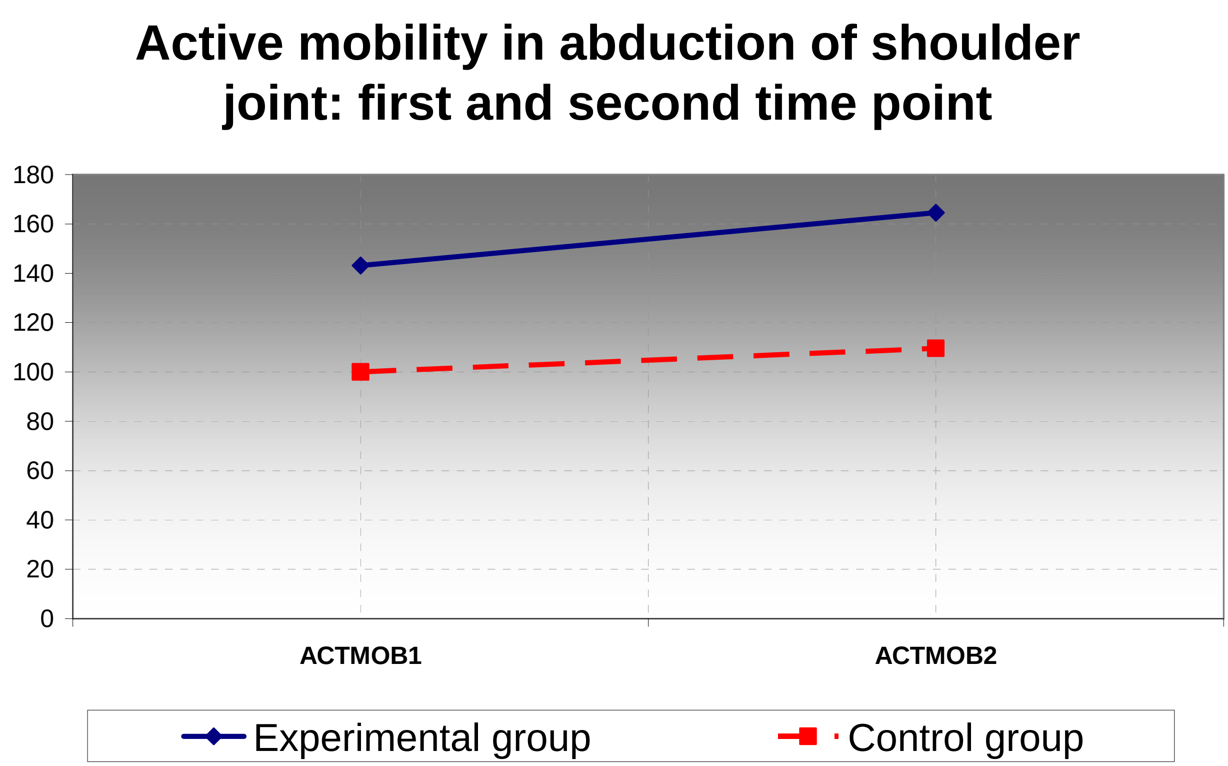


Figure 4.4.: Active abduction in participants

ACTMOB1 specifies the mean value of degrees of active abduction measured in the experimental group and the control group at the first time point (before the start of the treatment). ACTMOB2 specifies the mean value of degrees of active abduction measured in the experimental group and the control group at the second time point (after the last treatment).

The mean values of active abduction for the 11 patients of the experimental group were 143.18 at the first time point and 164.55 at the second time point. The results demonstrated a significant improvement of the active mobility in the abduction.

The mean values of active abduction for the 11 patients of the control group were 100.00 at the first time point and 109.55 at the second time point. Although this group also experienced improvement, it was not as significant as in the experimental group.

## 4.5. RESULTS OF THE PARAMETER "PASSIVE MOBILITY IN ABDUCTION OF THE SHOULDER JOINT WITH STABILISATION OF THE INFERIOR ANGLE OF THE SCAPULA"

Analysis of variance with repeated measurements at $\alpha = 0.05$ was employed to examine whether there was a difference in passive mobility in the abduction of the shoulder joint with stabilisation of the inferior angle of the scapula between the experimental and control groups from time point 1 to time point 2. Test statistical analysis reveals a significant time effect ($F = 73.151$; $p = 0.000$), and significant reciprocity (time*intervention) ($F = 9.401$; $p = 0.006$) between the experimental and control groups.

**Descriptive Statistics**

| | Group | Mean value | Standard deviation | N |
|---|---|---|---|---|
| **PAMOST 1** | Experimental group | 73,64 | 10,975 | 11 |
| | Control group | 55,91 | 21,659 | 11 |
| | Total | 64,77 | 19,054 | 22 |
| **PAMOST 2** | Experimental group | 90,00 | 9,487 | 11 |
| | Control group | 63,64 | 24,909 | 11 |
| | Total | 76,82 | 22,811 | 22 |

Table 4.3.: Descriptive statistics on passive abduction with stabilisation

N = sample size

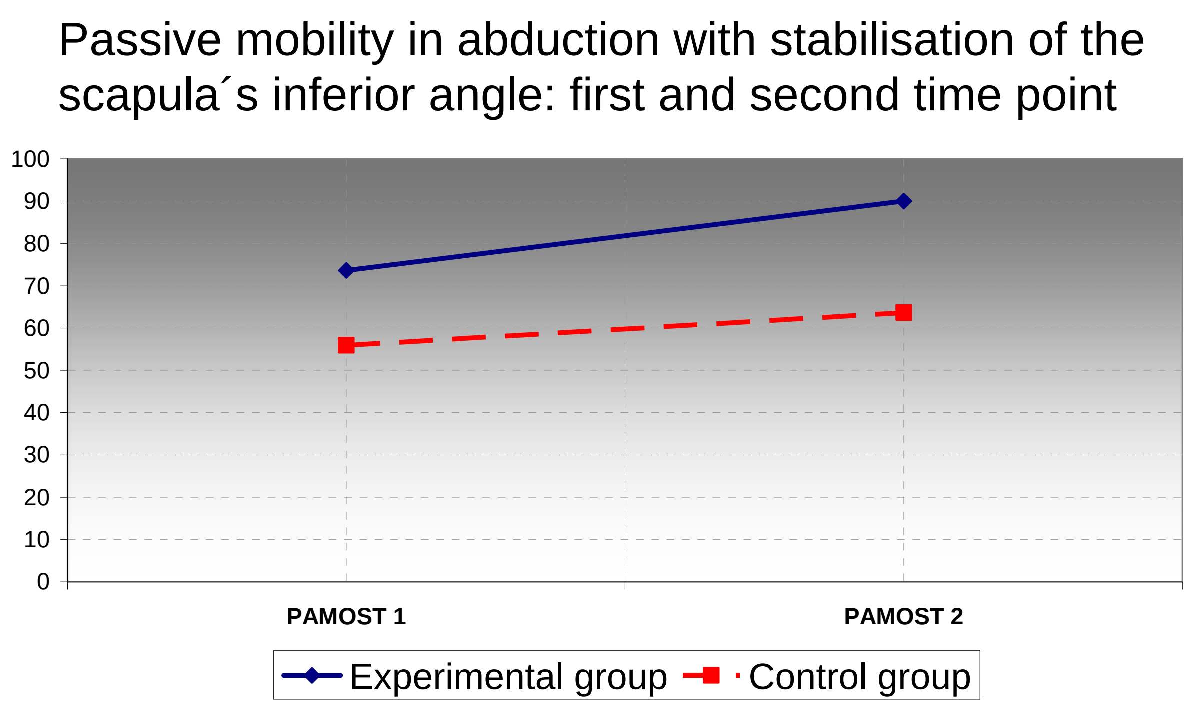


Figure 4.5.: Passive abduction with stabilisation

PAMOST1 specifies the mean value of degrees of passive mobility in the abduction of the shoulder joint with stabilisation of the inferior angle of the scapula measured in the experimental group and the control group at the first time point (before the start of the treatment). PAMOST2 specifies the mean value of the degrees measured in the experimental group and the control group at the second time point (after the last treatment). The mean value of passive abduction with stabilisation at the inferior angle of the scapula of the experimental group was 73.64 at time point 1 and 90.00 at time point 2. These results indicate an improvement regarding passive mobility.

The mean value of the degrees measured in the control group was 55.91 at time point 1 and 63.64 at time point 2. Although this group also experienced improvement, it was not as significant as in the experimental group.

## 4.6. RESULTS OF THE PARAMETER "PASSIVE MOBILITY IN ABDUCTION OF THE SHOULDER JOINT WITHOUT STABILISATION OF THE INFERIOR ANGLE OF THE SCAPULA"

Analysis of variance with repeated measurements at $\alpha = 0.05$ was employed to examine whether there was a difference in passive mobility in the abduction of the shoulder joint without stabilisation of the inferior angle of the scapula between the experimental and control groups from time point 1 to time point 2. Test statistical analysis reveals a significant time effect ($F = 14.559$; $p = 0.001$) and no significant reciprocity (time*intervention) ($F = 1.188$; $p = 0.289$) between experimental and control groups.

**Descriptive Statistics**

| | Group | Mean value | Standard deviation | N |
|---|---|---|---|---|
| **PAMONS 1** | Experimental group | 145,45 | 31,101 | 11 |
| | Control group | 103,64 | 48,067 | 11 |
| | Total | 124,55 | 44,931 | 22 |
| **PAMONS 2** | Experimental group | 161,82 | 21,826 | 11 |
| | Control group | 112,73 | 47,977 | 11 |
| | Total | 137,27 | 44,205 | 22 |

Table 4.4.: Descriptive statistics on passive abduction without stabilisation

N = sample size

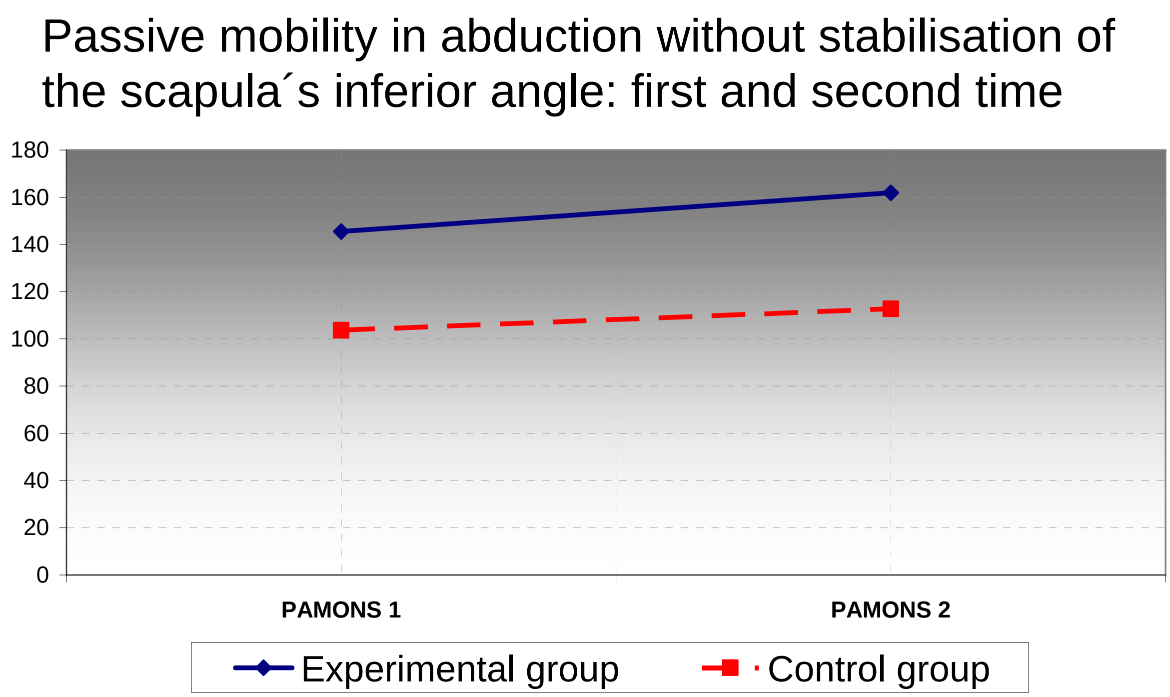


Figure 4.6.: Passive abduction without stabilisation

PAMONS1 specifies the mean value of degrees of passive mobility in abduction of the shoulder joint without stabilisation of the inferior angle of the scapula measured in the

experimental group and the control group at the first time point (before the start of the treatment). PAMONS2 specifies the mean value of the degrees measured in the experimental group and the control group at the second time point (after the last treatment). The mean values of the passive abduction with stabilisation of the inferior angle of the scapula in the 11 participants of the experimental group were 145.45 at time point 1 and 161.82 at time point 2. These results indicate a tendency towards improvement regarding passive mobility.
The mean values of the degrees measured in the 11 patients of the control group were 103.64 at time point 1 and 112.73 at time point 2. These results also indicate a tendency towards improvement.

### 4.7. RESULTS OF THE 101-POINT NUMERICAL RATE SCALE (NRS-101): MEASURING THE END-FEEL OF ABDUCTION OF THE SHOULDER JOINT

Analysis of variance with repeated measurements at $\alpha = 0.05$ was employed to examine whether there was a difference in the end-feel of the abduction of the shoulder joint without stabilisation of the inferior angle of the scapula between the experimental and control groups from time point 1 to time point 2. Test statistical analysis reveals a significant time effect ($F = 45.680$; $p = 0.000$) and significant reciprocity (time*intervention) ($F = 7.140$; $p = 0.015$) between experimental and control groups.

**Descriptive Statistics**

| | Group | Mean value | Standard deviation | N |
|---|---|---|---|---|
| **ENDF 1** | Experimental group | 34,09 | 19,139 | 11 |
| | Control group | 48,00 | 16,081 | 11 |
| | Total | 41,05 | 18,661 | 22 |
| **ENDF 2** | Experimental group | 15,00 | 14,601 | 11 |
| | Control group | 39,73 | 15,415 | 11 |
| | Total | 27,36 | 19,360 | 22 |

Table 4.5.: Descriptive statistics on the end-feel of abduction
N = sample size

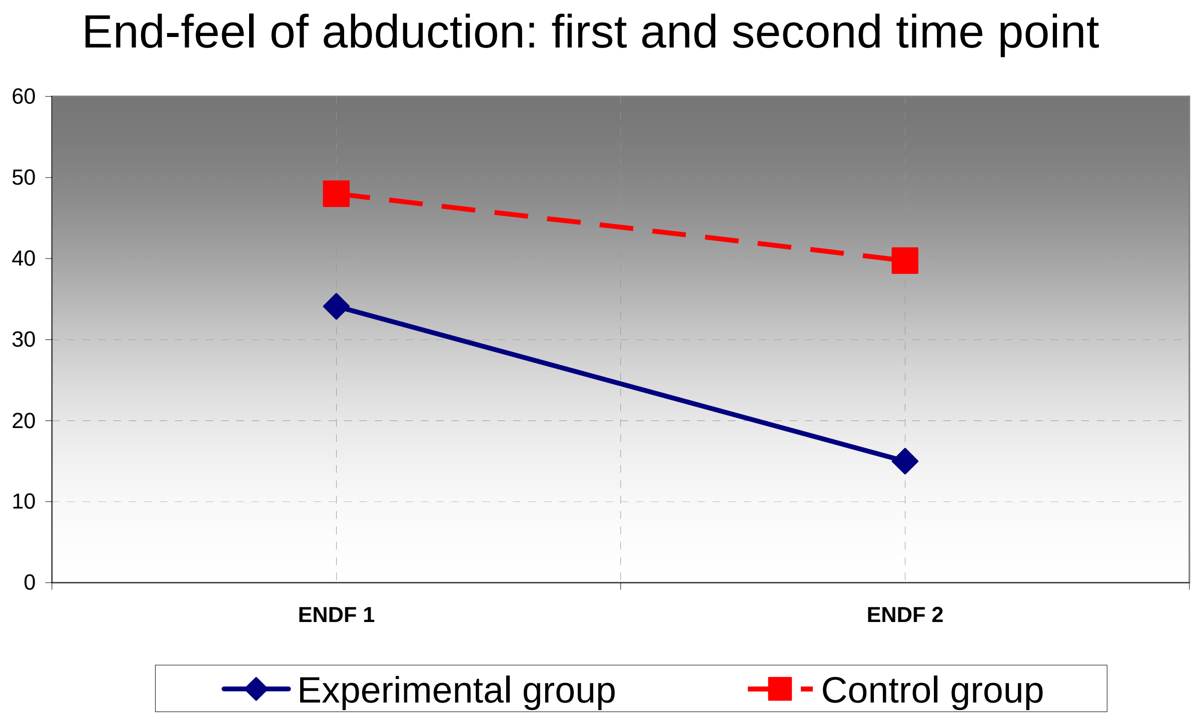


Figure 4.7.: End-feel of abduction of shoulder joint

ENDF1 specifies the mean value of the end-feel of the abduction of the shoulder joint in the experimental group and the control group at the first time point (before the start of the treatment). ENDF2 specifies the mean value of the experimental group and the control group (after the last treatment).

The mean values of the end-feel of the abduction of the shoulder joint in the experimental group were 34.09 at the first time point and 15.00 at the second time point.

There was an improvement in the end-feel from time point 1 to time point 2 in that it became “softer”. The mean values in the control group were 48.00 at the first time point and 39.73 at the second time point. The control group also showed improvement as the end-feel became “softer”, but not as significantly as the experimental group.

# 5. DISCUSSION

For the most part my hypothesis has been confirmed. From the first to the second time point the experimental group showed a significantly higher decrease in pain than the control group. The experimental group's degrees of active abduction and passive abduction with stabilisation of the inferior angle of the shoulder also improved to a greater extent than those of the control group. The experimental group's end-feel of abduction also showed a better improvement than that of the control group. The experimental group showed a tendency for an improvement of passive abduction without stabilisation of the scapula's inferior angle, yet the difference to the control group was not that significant.
Nevertheless, there are some points of criticism concerning the study that should definitely be discussed. Due to the specific time limit for the conclusion of the study only 22 participants could be examined, 11 of which were allocated to the control group and 11 belonged to the experimental group. This framework did not allow randomisation, meaning that no sample could be obtained from an available population by randomised selection. Based on such a sample an experimental group and a control group would have been defined by randomised allocation.
This is why precise inclusion and exclusion criteria were determined for this clinical study to achieve an experimental group and a control group as homogenous as possible. Those patients meeting the inclusion criteria were alternately allocated, in the order they came into the surgery, to the experimental group and the control group. This prevented me from deliberately allocating one or the other participant to a certain group.
Unfortunately the time limit did not allow me to perform a pilot study. When examining my first patients I found out that I could not measure the parameter "force". Many patients could not even take the starting position for the force test and were even less capable of holding it against the resistance of the osteopathic practitioner. Due to osteopathic considerations I introduced an additional parameter, namely "passive mobility in abduction of the shoulder joint without stabilisation of the scapula's inferior angle".
One should be aware of the fact that there are many parameters in field studies which cannot be controlled. For example, although the patients were always examined and treated on the same day, the time point varied. The participants may have experienced less pain in the morning than in the evening. It may also be possible that one day patients feel quite

well and hence show better results in active abduction of the shoulder joint than on the next appointment when they may feel worse. It was a benefit that the same days of the week were always chosen for examination and treatment (Wednesday, Friday), that is to say all the participants had the same period of time between the appointments. It was another advantage for the study that the same premises were always used.

A third time point would have been interesting, e.g. six weeks after the last treatment. This would have allowed conclusions on the durability of the therapeutic success. Unfortunately, it was not possible to include a third time point within the framework of this study.

The patients of the experimental group received osteopathic treatment free of charge. Those participants of the control group who, from the medical point of view, still needed osteopathic treatment after the conclusion of the study received further osteopathic treatment.

Harryman (1991) demonstrates that men are affected by complete ruptures of the supraspinatus tendon twice as often as women. An interesting feature of the study was that 73% of the participants were women and only 27% were men.

As I could not find any study on a comparable subject it was difficult to compare my study with other studies on the state-of-the-art. However, compared to the study conducted by Fichtinger P. (2004) described in Chapter 2.4., I examined many more patients for my study. In her study it was the examiner who allocated a certain score to each participant. In my study I wanted to avoid that. The patients had to indicate the intensity of their current pain on the visual 101-point numerical analogue scale. The measurement with a goniometer proved to be a reliable and reproducible method. The use of the 101-point numerical analogue scale for the determination of the end-point has already been tested for its reliability and validity by Jensen (1986). However, it would have been possible to use many more parameters in this study to gain even more results.

It would also have been an advantage if I had not conducted the osteopathic treatment myself and if all tests had been carried out by a second independent practitioner.

By conducting this study I realised how difficult it is to perform a meaningful clinical study without institutional support. But even under the most favourable conditions it is still difficult to find comparable groups of participants and conduct tests which have already been tested for their validity.

# 6. ACKNOWLEDGEMENTS

I owe special thanks to Dr. Dieter Kerngast, who not only offered me a very interesting form of cooperation more than three years ago but also supported me in the writing of my Master's thesis. Without his support I would not have been able to conduct a study of this kind.

I would also like to express my gratitude to Mag. Heidelinde Maria Hahn. She supported me in working out and evaluating the statistical data.

I am also deeply indebted to my husband Wolfgang for all the patience he has shown me.

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# 8. APPENDIX

## 8.1. LIST OF FIGURES

Figure 4.6.: Passive abduction without stabilisation. Data analysis software SPSS 11.5. for Windows and Microsoft Excel.

Figure 4.7.: End-feel of abduction of shoulder joint. Data analysis software SPSS 11.5. for Windows and Microsoft Excel.

Table 4.1.: Descriptive statistics on pain intensity. Data analysis software SPSS 11.5. for Windows and Microsoft Excel.

Table 4.2.: Descriptive statistics on active abduction.
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Table 4.3.: Descriptive statistics on passive abduction with stabilisation. Data analysis software SPSS 11.5. for Windows and Microsoft Excel.

Table 4.4.: Descriptive Statistics on passive abduction without stabilisation.
Data analysis software SPSS 11.5. for Windows and Microsoft Excel.

Table 4.5.: Descriptive statistics on the end-feel of abduction. Data analysis software SPSS 11.5. for Windows and Microsoft Excel.

## 8.2. ABBREVIATIONS

| | |
|---|---|
| ACTMOB | active mobility |
| CF | compressive forces |
| ENDF | end-feel of abduction |
| N | sample size |
| PAIN | pain |
| PAMONS | passive mobility in abduction without stabilisation of the scapula's inferior angle |
| PAMOST | passive mobility in abduction with stabilisation of the scapula's inferior angle |
| T | traction |