Body Composition in Female Patients with Adhesion Capsulitis of the Shoulder: A Case-Control Study

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Abstract

Background: Many studies have attempted to clarify factors associated with the development of shoulder periarthritis. In its early stage, omalgia impairs normal, everyday life. Due to this pain, muscle force decreases in the affected side of the upper limb, and a change occurs in body composition distribution, especially in the upper limb. Currently, body composition distribution can be measured using dual energy X-ray absorptiometry (DEXA).

Methods: 102 patients with unilateral shoulder pain over 3 months (5 males and 97 females, mean age: 62.5 ± 10.5 years) were assigned to the shoulder pain group (painful group). The control group consisted of 237 patients without shoulder pain (20 males and 197 females, mean age: 59.8 ±14.2 years). These factors were measured using a QDR-4500 DEXA scanner (Hologic Co., Ltd.).

Results: Mean values of bone mineral density were 0.57 ±0.09 g/cm^2 on the affected side and 0.59 ± 0.08 g/cm^2 on the non-affected side in the painful group. Mean values in the control group were 0.57 ± 0.14 g/cm^2 on the left side and 0.58 ±0.09 g/cm^2 on the right side. There was no significant difference between the shoulder with and without pain, affected and non-affected side. Mean proportions of the upper limb that was fat were 40.1 ± 9.5% on the affected side and 35.7 ±9.8% on the non-affected side in the painful group. In the control group, the means were 39.2 ±11.1% on the left side and 37.5 ± 10.9% on the right side. The mean muscle masses of the upper limb were 1548.5 ±304.2 g on the affected side and 1723.5 ±321.5 g on the non-affected side in the painful group. There was a significant difference between the affected and non-affected side.

Conclusions: We measured the body composition of the upper limb. Muscle mass of upper limb was significantly different between the affected and non-affected sides.

Background

The pathogenesis, pathophysiology, and background of adhesion capsulitis is largely unknown. There are also considerable individual differences in the disease course, but almost all patients suffer intense pain. Though symptoms may improve during the “freezing” period, which typically occurs at 3 or 4 months after onset, the majority of cases transition to the “frozen” stage in which range of motion (ROM) is limited. Symptoms can last up to four years in some cases, but the disease can also improve spontaneously without any treatment. Pain limits joint function and decreases muscle strength. Shoulder pain often lasts longer than pain in other joints and is likely to have a more dramatic effect on muscle strength. This long-lasting pain also influences use, so it can impact body composition. In 1978, Grey found that the shoulder returned to normal within 2 years in 24 of 25 patients, both in terms of pain and joint function. The subjects in the present study represent patients within two years of onset.[1] In a previous study, Ogawa [2] noted that adhesion capsulitis was more common in the non-dominant arm, and in patients between the ages of 40 and 60 years. These characteristics were also true in our study, in which the non-dominant arm was affected in 58% of cases, and the mean age of patients was 54.5 years.

In this study, we used bone densitometry (dual-energy x-ray absorptiometry; DEXA) with the aim of measuring upper limb muscle mass and fat mass in patients with and without shoulder pain. **While there have been studies on knee and hip joints, no studies exist on shoulder pain.** This method allows calculating muscle mass in grams or as percentage of overall body mass. Furthermore, more accurate statistics can be obtained by combining muscle mass with body fat percentage.

Methods

Patient characteristics

Participants were 81 female patients (54.5 ± 10.0 years) with unilateral shoulder pain that developed within two years, having persistent pain at the time of assessment, without clear lesions (e.g., cuff tear, impingement syndrome, etc.). **The study was conducted as a retrospective study of patients who came in for osteoporosis health screening. Consent forms were obtained from all participants. At the time of their health screening, shoulder pain was checked and ROM was measured. Since this was an osteoporosis screening, there are more women than men in the participant group.** Patients who had already been surgically treated were excluded. The patients with capsulitis were further divided into two subgroups: patients with a limited ROM ≤ 90° of abduction were assigned to the frozen group; patients without ROM limitations were assigned to the freezing group. They were also sub-classified by time since onset: patients within 6 months of onset and 7 or more months since onset were allocated to groups A and B, respectively. A control group matched for age, sex, height, dominant hand and lumbar bone mineral density (BMD) was selected among 502 individuals, from the same region, without history of pain or trauma to joints of the upper limbs, and who were also assessed by DEXA. All participants with history of fracture and other trauma to the upper limbs were excluded from the study.

Body composition measures

Body composition was measured by DEXA (QDR4500, Hologic), which measures body composition in grams. The surveyed parameters were fat, bone, and lean muscle mass. For this study, fat percentage was calculated as the ratio of fat mass to muscle mass and total mass of the arm. The paired-t test and students-t test were used for analysis. Significance level was calculated as $p < 0.05$.

Results

Background of matched controls

Background characteristics of 81 matched controls and 81 patients with capsulitis were compared. There were no significant differences between the two groups in terms of age, weight, height, dominant hand, or lumbar BMD.

Basic data of the capsulitis group

The non-dominant arm was affected in 47 patients (58.0%). The mean duration from onset was 8.4 ± 2.8 months. Nineteen patients (23.5%) had a history of diabetes mellitus.

Muscle mass and fat percentage

In the control group, left arm and right arm muscle mass was not significantly different (left arm mean = 1589.6 g, right arm mean 1678.9 g). In women without adhesion capsulitis, muscle mass was similar for both arms. This is likely due to there being a balance in dominant hands. In the capsulitis group, there was no significant difference between left arm muscle mass and right arm muscle mass overall (Fig. 1).

Figure 1. Body composition weight (grams) for muscle mass in the capsulitis and control groups

There was no significant difference in muscle mass in both the capsulitis and control groups.

For fat percentage, there was no significant difference between the right and left arms in the control group (left arm mean = 40.1%, and right arm 38.1%). For fat percentage in the capsulitis group, the mean left arm fat percentage was 41.1%, and the mean right arm fat percentage 38.1 ± 8.9%; the difference was not significant (Fig. 2).

There was no significant difference between the fat percentage of left and right sides in both the capsulitis and control groups.

There was a significant difference between the muscle mass of the affected side, mean = 1497.3 g, and healthy side, mean = 1669.7. Muscle mass was significantly higher on the healthy side in the capsulitis group ($p < 0.05$). The affected side fat percentage was 42.9%, with the healthy side fat percentage at 36.3%; the fat percentage was higher on the diseased side in the capsulitis group, but the difference was not significant (Fig. 3).

There was no significant difference between the healthy and affected sides with respect to fat percentage.

Comparison: freezing and frozen stages

Muscle mass was marginally higher in the control group and fat percentage was marginally higher in the capsulitis group, but the differences were not significant. Thus, the capsulitis group was subdivided into the freezing and frozen groups for subgroup comparison, which showed that muscle mass on the diseased size in the frozen group was significantly lower than the freezing group (p 0.05; Fig. 4). Furthermore, the fat percentage of the affected side in the frozen group was significantly higher than the that of the freezing group ($p < 0.05$; Fig. 5).

There was no significant difference in muscle mass of the unaffected side in the freezing phase, but there was a significant difference in the unaffected side in the frozen phase.

There was no significant difference in fat percentage of the affected side in freezing phase, but there was a significant difference in the unaffected side in the frozen phase.

Discussion

The term scapulohumeral periarthritis was first coined by French surgeon Duplay in 1872 [3]. Later, Naviaser first validated pathological arthrogryposis and adhesion of the bone head and articular capsule in 1945 and renamed the disease “adhesive capsulitis.”[4] Bunker [5] reported that capsulitis occurs in 36% of patients with diabetes mellitus. In the present study 23.5% of capsulitis patients were diabetic. However, there was no significant difference in body composition between the diabetic and nondiabetic patients, thus, diabetes did not seem to affect body composition. There are many studies that have incorporated the assessment method used in the present study. For instance, Brodie et al. [6] detailed the effectiveness of measuring body composition with DEXA, and Bendtsen et al. [7] assessed the high accuracy of DEXA in an in vivo porcine experiment. Further, Kohrt [8], Clasey [9], and Jensen [10] all reported high accuracy and repeatability of DEXA, suggesting the high reliability of DEXA assessments.

With regards to muscle mass, Madsen et al. [11] reported a correlation between lower limb muscle mass percentage on DEXA and muscle strength in young women. Since the present assessment of body composition showed significantly lower muscle mass on the affected side, capsulitis likely has a negative impact on muscle strength. Hannafin et al. [12] classified capsulitis into four stages, the preadhesive, freezing, frozen and thawing stages. We found a significant difference in muscle strength and fat percentage between the freezing and frozen groups, but the freezing stage is characterized by pain but no limitation of ROM and the motor function loss in the upper limb is not marked, which likely explains why body composition was not altered. However, there is marked limitation of ROM, and loss of motor function in the upper limb is salient in the frozen stage, resulting in changes in body composition.

Conclusion

DEXA was used to measure body composition in patients with capsulitis, and 23.5% of capsulitis patients were diabetic. Though there was no difference between the unaffected and affected arms in terms of fat percentage, muscle mass was significantly lower on the affected side. **It is important to note that diabetic patients are more likely to have peri- capsulitis, which means that diabetes should be noted in treatment. The fact that muscle mass is depressed on the affected side indicates that continuous training is necessary even if the pain and ROM improves.**

Abbreviations

BMD
bone mineral density
DEXA
dual energy X-ray absorptiometry

ROM
range of motion

Declarations

Ethical approval and consent to participate: This research was approved by the Fukaya Central Hospital Research Ethics Committee (Ethics Approval Number 2020-002). All patients provided written informed consent after receiving an explanation about the study.

Consent for publication: Not applicable._

Availability of data and materials: The datasets during and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: **MF was in charge of data collection and analysis, and statistical processing. MI discussed the data analysis and contributed significantly to the writing of the manuscript. All authors read and approved the final manuscript.**

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Figures

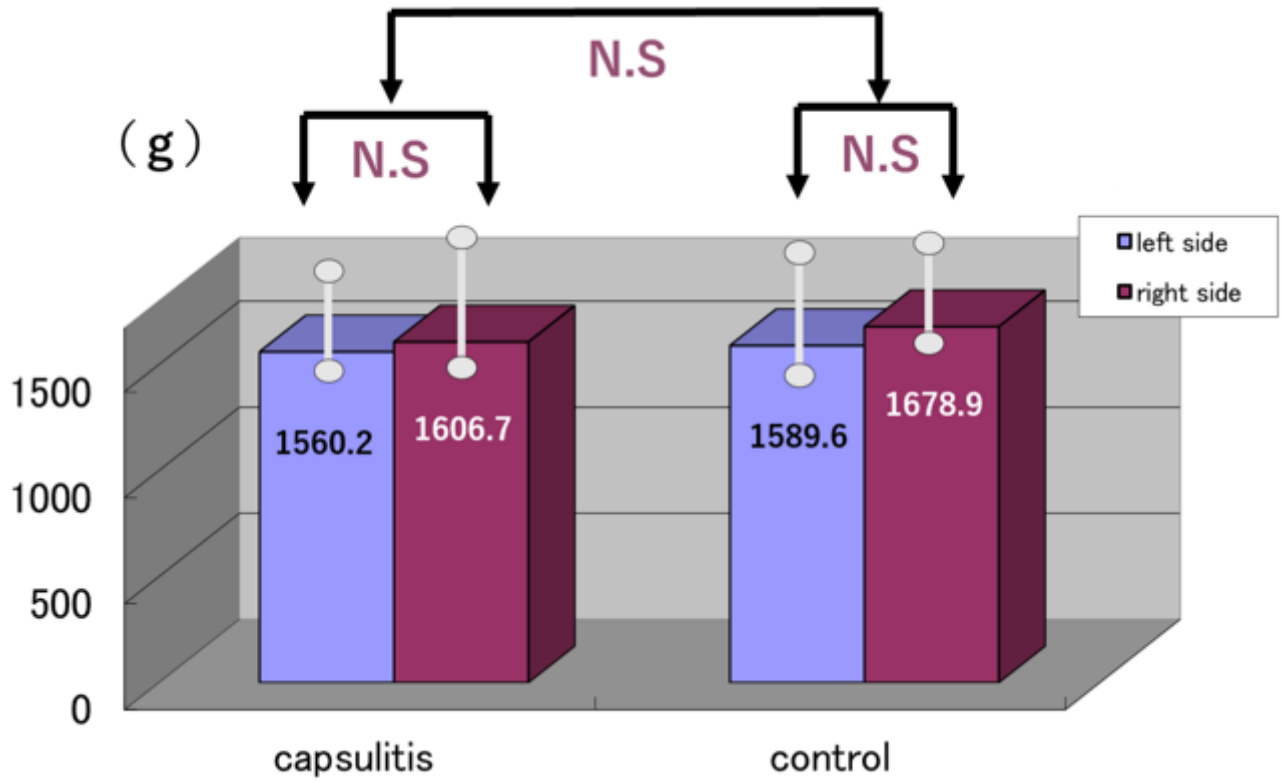

Figure 1

Body composition weight (grams) for muscle mass in the capsulitis and control groups

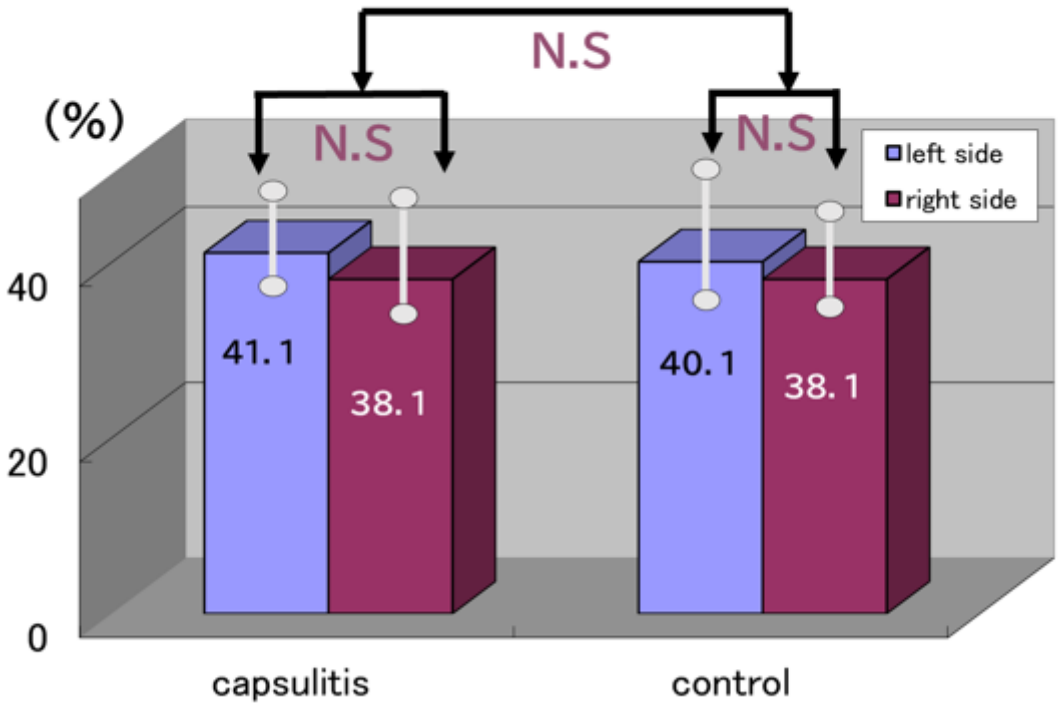

Figure 2

Body composition (% fat) in capsulitis and control groups.

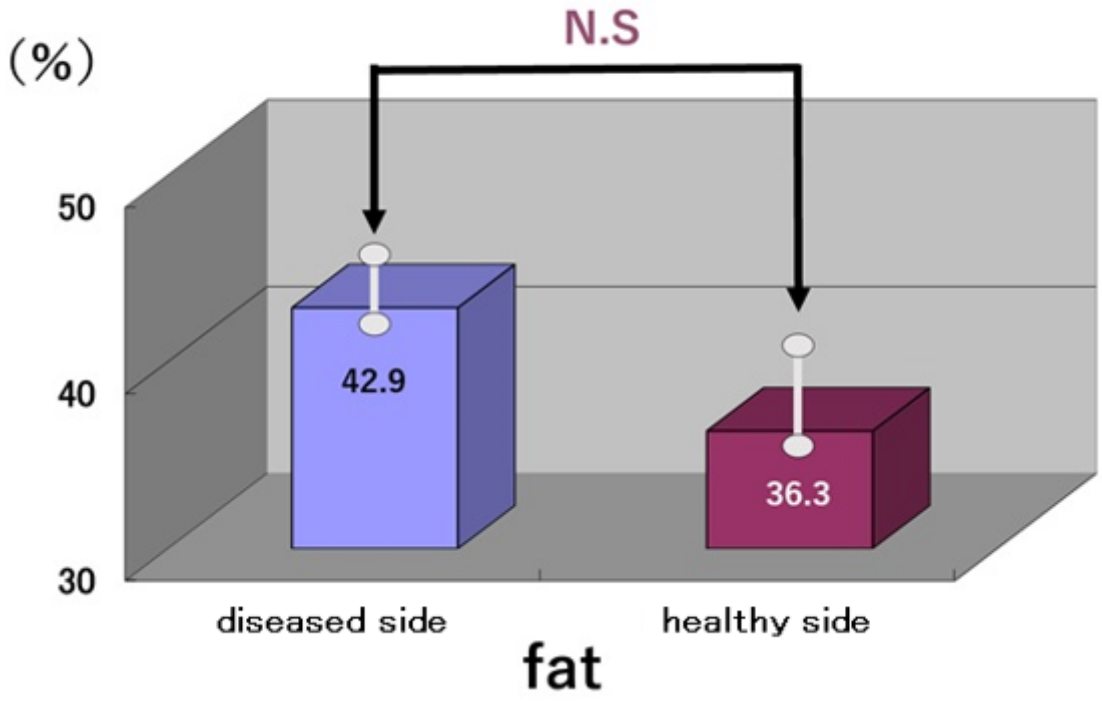

Figure 3

Body composition f(%fat) in the capsulitis group.

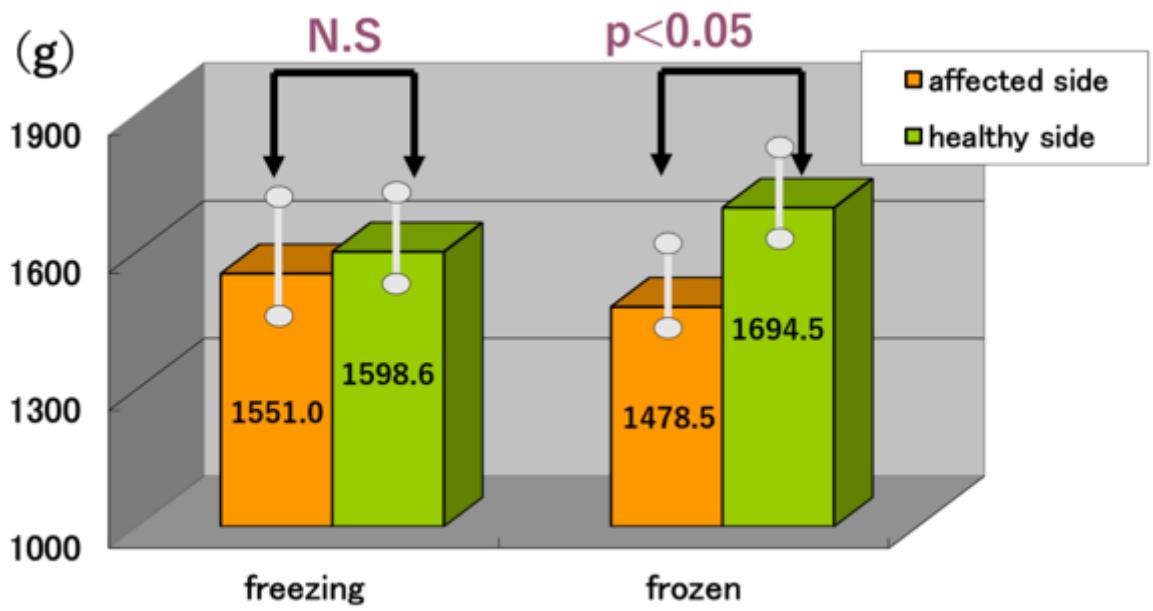

Figure 4

Comparison of the freezing and frozen groups (muscle mass)

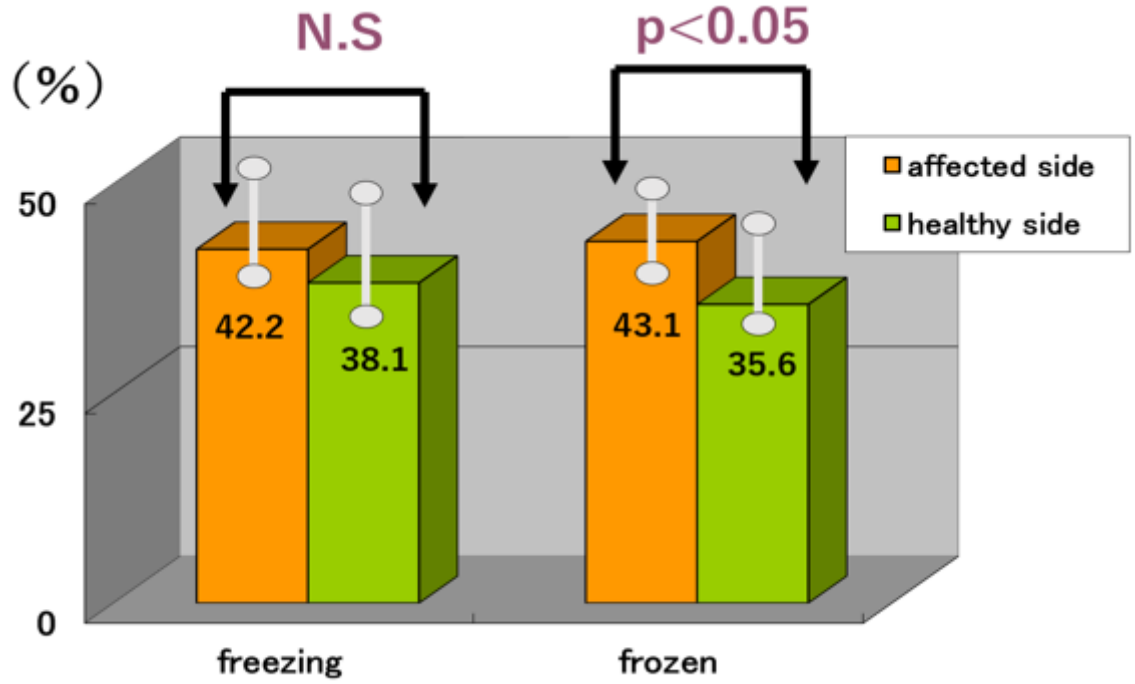

Figure 5

Comparison of the freezing and frozen groups (fat mass).