Prognostic Factors in Nonoperative Therapy for Chronic Symptomatic Calcific Tendinitis of the Shoulder

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Objective. To define prognostic factors in chronically symptomatic patients with calcific tendinitis of the shoulder.

Methods. We evaluated 420 patients (488 shoulders) in the context of a prospective cohort study. Epidemiologic data were assessed. The radiographic and sonographic appearance of the calcific deposits was classified. The mean period of nonoperative therapy was 4.4 years (range 0.5–13.7 years). After referral to our institution, standardized nonoperative therapy was continued for a minimum of 3 months. Failure of nonoperative therapy was defined as the persistence of symptomatic calcific tendinitis of the shoulder after a minimum of 6 months. Prognostic factors (determined at \( P < 0.05 \) by chi-square test) were analyzed by logistic regression.

Results. Of the 420 patients, 269 (64%) were women, 151 (36%) were men. The mean age of the patients was 51.3 years (range 28–84 years). Occurrence of calcific tendinitis of the shoulder was unilateral in 84% and bilateral in 16%. Gärtner type I calcific deposits were found in 37%, type II in 32%, and type III in 31%. Failure of nonoperative therapy was observed in 114 patients (27%). Negative prognostic factors were bilateral occurrence of calcific tendinitis of the shoulder, localization to the anterior portion of the acromion, medial (subacromial) extension, and high volume of the calcific deposit. Positive prognostic factors were a Gärtner type III deposit and a lack of sonographic sound extinction of the calcific deposit.

Conclusion. Our findings demonstrate the existence of prognostic factors in the nonoperative treatment of chronic symptomatic calcific tendinitis of the shoulder. Guidelines for optimal treatment can be implemented according to these factors to avoid a long-term symptomatic disease course.

The prevalence of calcific deposits in rotator cuff tendons is \(~3\%\) in asymptomatic shoulders, with about one-third of patients becoming symptomatic within a period of 3 years (1). Reports on the prevalence in symptomatic shoulders vary considerably. Bosworth (1) observed that 30–45% of patients develop symptoms throughout the course of the disease, while other investigators report a prevalence of calcific deposits of up to 50% in symptomatic shoulders (2). To date, no clinical or radiologic parameters have been developed that can predict whether a calcific deposit will become clinically symptomatic (3–5).

The etiology of calcific tendinitis of the shoulder differs principally from degenerative rotator cuff disease, which affects the matrix composition of the tendon. Uhthoff and coworkers (6,7) described calcific tendinitis of the shoulder as a self-limiting condition arising in the viable rotator cuff tendon. The disease progresses in cyclical phases and results in spontaneous resolution of the calcification. Bosworth (1) found the rate of radiographic resolution of calcific deposits to be 6.4% per year, with 9.3% of deposits resolving within 3 years. Wölk and Wittenberg (8) reported a sonographic resolution rate of 82% within 8.6 years of nonoperative therapy.

No study has yet been able to define the characteristics for determining whether calcific deposits will progress to resolution, remain asymptomatic, or persist to become clinically symptomatic. The diagnostic tools used in clinical practice allow neither the reliable staging of the disease nor the prediction of its future clinical course.
There is consensus in the literature that the first treatment of choice in symptomatic calcific tendinitis of the shoulder is nonoperative therapy. Noel (9) described good and excellent clinical results in 50.4% of 125 patients at 6 months after nonoperative treatment of symptoms. In a study by Wölk and Wittenberg (8), 70% of patients were completely or partially asymptomatic after a mean of 49 months of nonoperative treatment. A rate of up to 30% of patients with persistent symptoms from calcific deposits despite nonoperative treatment has been reported (8). Ultimately, 10–15% of patients will require surgical intervention (10).

We designed a prospective cohort study that included patients with chronic, symptomatic calcific tendinitis of the shoulder despite nonoperative therapy. The aim of this study was to define the prognostic factors in chronically symptomatic patients with calcific tendinitis of the shoulder. Knowledge of these factors can provide guidelines for physicians to use in optimizing treatment and in avoiding long-term symptomatic disease courses.

**PATIENTS AND METHODS**

**Study design.** We performed a prospective cohort study that included 439 patients with calcific tendinitis of the shoulder. Inclusion criteria were the presence of radiographically and sonographically proven calcific deposits in a rotator cuff tendon and the presence of clinically symptomatic calcific tendinitis of the shoulder requiring continuation of treatment at the time of presentation at our institution. Exclusion criteria were previous surgical interventions, needling, application of ultrasound therapy, or extracorporeal shock wave therapy (ESWT), as well as the presence of rheumatoid arthritis or concomitant diseases of the affected shoulder.

Primary end points were clinical improvement allowing cessation of nonoperative treatment and failure of nonoperative therapy requiring advanced therapeutic measures. A total of 19 patients were withdrawn from the study because their treatment was transferred to another institution or another physician. The final data analysis for the study consisted of 420 patients (488 shoulders), with a followup rate of 95.7%.

**Nonoperative therapy.** All patients had previously received nonoperative treatment from general practitioners, rheumatologists, or orthopedic surgeons, which included physical therapy, manual therapy, electrotherapy, iontophoresis, systemic use of analgesics and nonsteroidal antiinflammatory drugs (NSAIDs), and up to 3 subacromial injections of corticosteroids. The patients were then referred to our Orthopedic Outpatient Clinic because of the persistence of clinically symptomatic calcific tendinitis of the shoulder. During the first consultation at our institution, we performed standardized clinical, radiographic (true anteroposterior [AP] view and outlet view radiographs, if not already available) and sonographic assessments. Nonoperative treatment was continued for a minimum of 3 months according to a standardized algorithm at our institution, consisting of physical therapy (including application of cold or heat), manual therapy, and systemic use of NSAIDs.

**Failure of nonoperative therapy.** Failure of nonoperative therapy was defined as persistence of symptomatic calcific tendinitis of the shoulder after a minimum of 6 months of nonoperative treatment, including a minimum of 3 months of standardized nonoperative treatment at our institution. The mean symptomatic period was 4.4 years (range 0.5–13.7 years). Failure of nonoperative therapy was the primary end point of the study, after which advanced therapeutic measures were initiated. These could involve surgical intervention, needling, ultrasound application, or ESWT.

At our institution, arthroscopic removal of the calcific deposit is the treatment of choice for chronic symptomatic calcific tendinitis of the shoulder. Surgery was performed with the patient's informed consent. The authors would like to emphasize that the option of surgical intervention did not influence the definition of failure of nonoperative therapy as the primary end point of the study. Before surgery, standardized radiologic investigations (radiography, if not currently available, and sonography) were performed as described above.

**Clinical and demographic assessments.** Demographic details such as age, sex, profession, and periods of professional disability were recorded. The patient's medical history included the onset and duration of symptoms, the duration and type of previous nonoperative therapy, medication, allergies, coexisting medical conditions, and specific details about the affected shoulder (dominant or nondominant arm, unilateral or bilateral occurrence, and unifocal or multifocal distribution of calcific deposits).

**Radiographic assessments.** Radiographic examinations consisted of a true AP view, with a caudal tilt of the x-ray beam of 30° for free projection of the subacromial space (Rockwood view), and an outlet view of the affected shoulder in neutral position. An independent observer analyzed the calcific deposits according to the radiographic classification system described by Gärtner and Heyer (11) (types I–III, where type I = dense with well-defined borders, type II = dense with indistinct borders or transparent with well-defined borders, and type III = transparent with indistinct borders), as well as the classification system described by the French Society of Arthroscopy (SFA) (12) (types A–D, where A = dense, well-defined, and circumscribed, type B = dense, well-defined, and segmented, C = transparent and nonhomogenous, and D = dystrophic deposit at the origin of the tendon). The locations of the deposits were determined in the true AP and outlet views.

For the present study, we established a system for radiographic localization of the calcific deposits that was analogous to the sonographic localization system (quadrant technique) previously described (13). In the true AP view, a perpendicular line was drawn at the lateral border of the acromion. The distance between the perpendicular line and the medial border of the calcific deposit was measured (Figure 1A). For those with medial orientation of the deposit, the distance (in mm) was specified as minus, and for those with lateral orientation, the distance was specified as plus. In the outlet view, 5 sectors originating from the center of the glenoid were defined. Sector 0 was defined as the region anterior to the...
Methods of localizing calcific deposits on true anteroposterior (AP) view (A) and outlet view (B) radiographs. On radiographs in AP view, the distance between the perpendicular line and the medial border of the calcific deposit was measured (in mm) and was specified as minus in those with a medial orientation of the deposit and as plus in those with a lateral orientation. On radiographs in outlet view, 5 sectors (delineated 0–4 from anterior to posterior, as described in Patients and Methods) originating from the center of the glenoid were defined, and all sectors that were affected by a calcific deposit were recorded.

The occurrence of calcific tendinitis of the shoulder was identified as a significant prognostic factor. In the 352 patients with unilateral occurrence, failure of nonoperative therapy was observed in 78 of them (22%), whereas in the 68 patients with bilateral occurrence, failure of nonoperative therapy was observed in 36 of them (22%). The probability of failure of nonoperative therapy was >2-fold (53% versus 22%) in the group of patients with bilateral occurrence; this difference was statistically significant ($P < 0.05$).

Radiographic findings. Gärtnertype I deposits were found in 156 of the 420 patients (37%), type II deposits in 135 (32%), and type III deposits in 129
(31%). Failure of nonoperative therapy was observed in 50 of the 156 patients with type I deposits (32%), 32 of the 135 with type II deposits (24%), and 22 of the 129 with type III deposits (17%) (Figure 2). The presence of a Gärtner type III deposit was a significant \( (P < 0.05) \) positive prognostic factor.

SFA type A deposits were found in 71 of the 420 patients (17%), type B in 78 (19%), type C in 191 (45%), and type D in 80 (19%). Failure of nonoperative therapy was observed in 17 of 71 patients (24%) with type A deposits, 35 of 78 (45%) with type B deposits, 51 of 191 (27%) with type C deposits, and 13 of 80 (16%) with type D deposits. None of the SFA types was identified as a significant prognostic factor.

In the true AP view with a line drawn perpendicular to the lateral border of the acromion, 222 of the 328 calcific deposits in patients with failure of nonoperative therapy (68%) were localized lateral to the line, whereas the other 106 calcific deposits (32%) extended medial to the line (Figure 3). Medial extension of the calcific deposit was a negative prognostic factor, significantly increasing the probability of failure of nonoperative therapy \( (P < 0.05) \).

In the outlet view, 27 of the total of 547 calcific deposits (5%) were localized in sector 0, 260 (48%) in sector 1, 156 (29%) in sector 2, 73 (13%) in sector 3, and 31 (6%) in sector 4 (Figure 4). The proportion of patients with failure of nonoperative therapy in relation to the prevalence of calcific deposits per sector is shown in Figure 4. Localization of calcific deposits in sector 1 was identified as a significant negative prognostic factor \( (P < 0.05) \).

The mean \( \pm \) SD volume of calcific deposits was 1,550 \( \pm \) 2,940 mm\(^3\) (range 3–26,250). A high volume of calcific deposits was found to be a significant negative prognostic factor \( (P < 0.05) \) (Figure 5).

**Sonographic findings.** On sonography, a sharp cranial contour of the calcific deposit was found in 30 of 331 patients (9%), an indistinct contour in 293 (89%), and no cranial contour in 8 (2%). Inside the deposit, sound extinction was present in 102 of 331 patients (31%) and hyperdensity in 229 (69%). Complete sound extinction distal to the deposit was observed in 72 of 331 patients (22%), incomplete sound extinction in 208 (63%), and no sound extinction in 51 (15%). Failure of nonoperative therapy was observed in 41 of 72 patients (57%) with complete sound extinction, 61 of 208 (29%) with incomplete sound extinction, and 20 of 51 (39%) with no sound extinction.
with incomplete sound extinction, and only 3 of 51 (6%) with no sound extinction. Lack of sound extinction was a significant positive prognostic factor ($P < 0.05$).

There was no significant correlation between the sonographic parameters and the radiographic parameters.

In summary, the prognostic factors that significantly ($P < 0.05$) increased the probability of failure of nonoperative therapy (negative prognostic factors) were bilateral occurrence of the calcific deposit, localization to the anterior portion of the acromion, medial (subacromial) extension, and high volume of the calcific deposit. Prognostic factors that significantly ($P < 0.05$) reduced the probability of failure of nonoperative therapy (positive prognostic factors) were a Gärnter type III calcific deposit and lack of sonographic sound extinction of the calcific deposit.

**DISCUSSION**

Most studies on the therapeutics of calcific tendinitis of the shoulder focus on the results after ESWT (15,16), needling (17), ultrasound therapy (18), or surgical intervention (19). Recently, the results of mesotherapeutic application of disodium EDTA for the treatment of calcific deposits were also reported (20). Studies on the natural course of the disease and nonoperative treatment modalities are rare. Wölk and Wittenberg (8) reported good and excellent results of nonoperative therapy in 70% of patients after a mean period of 60 months. However, even with these results, up to 30% of their patients remained symptomatic and required further treatment. Significant prognostic factors in the nonoperative therapy for calcific tendinitis of the shoulder have not been described in the literature. Noel (9) reported an association of female sex and persistent SFA type C deposits with a negative clinical outcome. However, no evidence-based data were given.

The findings of this study demonstrate the existence of prognostic factors in the nonoperative therapy for chronic symptomatic calcific tendinitis of the shoulder. Anterior subacromial localization of the calcific deposit was identified as a negative prognostic factor. In histologic studies reported elsewhere, the majority of calcific deposits were localized to the bursal side of the rotator cuff tendon (21). A concomitant inflammatory reaction of the adjacent subacromial bursa was a common finding. Swelling of the rotator cuff and the subacromial bursa result in restriction of the subacromial space and may provoke a symptomatic intrinsic impingement syndrome (22,23).

The anterior portion of the acromion is an anatomic site that is known to be predisposed to extrinsic (outlet) subacromial impingement (24). Our findings suggest that intrinsic impingement induced by a calcific deposit seems to be of particular pathogenetic relevance when localized under the anterior portion of the acromion. This is reflected by the fact that failure of nonoperative therapy was observed more frequently in sector 1 of the calcific deposit.

We also found that a high-volume calcific deposit was a negative prognostic factor. Large calcific deposits were more likely to be associated with chronic symptomatic courses. The severity of symptoms of intrinsic impingement appears to increase in relation to the size of the calcific deposit. Furthermore, increasing size seems to be a risk factor for the persistence of symptoms.

The presence of a Gärnter type III calcific deposit and the lack of sonographic sound extinction were identified as positive prognostic factors. Previous studies suggested that a transparent, fluffy radiographic appearance with poorly defined borders of the calcific deposit (Gärnter type III), as well as the lack of sonographic sound extinction are indicators for the resorptive phase of the disease (21,25). Our clinical data demonstrated that failure of nonoperative therapy occurred less frequently in this group of patients. However, we did not perform radiographic examinations to prove that there was radiographic resolution of the calcific deposit in patients who were asymptomatic after nonoperative therapy. Indeed, the current literature shows that reli-

![Figure 5. Failure of nonoperative therapy in patients with calcific deposits of the shoulder classified radiographically according to the volume of the calcific deposit. The volume of the calcific deposit was measured on the true anteroposterior and outlet radiographic views by calculating the volume of the cuboid (breadth times the length times the depth; see Patients and Methods for details). Open bars indicate patients with failure of nonoperative therapy; solid bars indicate the total number of patients. – = increase in volume is a negative prognostic factor ($*= P < 0.05$). Numbers at the top of the bars are the values represented by the bars.]
able classification of the stage of the disease cannot be achieved by radiologic means (12,26,27).

It is a limitation of our study that the numbers of cases related to the sonographic factors as well as to some degree of the radiographic factors were reduced for methodologic reasons. This might have influenced the results of correlation between sonographic and radiographic factors and might also have reduced the power of the multivariate analysis. However, we were able to determine significant radiologic prognostic factors.

Classification of the morphologic aspects of calcific deposits based on radiographic assessment of morphology is not infallible. In intraobserver and interobserver studies, the reliability and reproducibility of the Gartner classification system were only moderate to satisfactory (28). Similar results are reported for other classification systems based on radiography (29). The diversity of nonoperative therapy applied by previous physicians who may have treated the patients is another potential limitation of the study. We included only patients who had received purely symptomatic treatment (NSAIDs, analgesics) prior to this study. To guarantee comparability of results, we also required that none of the study patients had undergone advanced therapeutic measures aimed at inducing or accelerating the resolution of calcific deposits (needling, ultrasound, ESWT).

The definition of failure of nonoperative therapy is an essential part of the study design, since it was the primary end point. The definition was based on a review of available research data reported in the literature that were related to the recommended type and duration of nonoperative treatment (2,10,11,19,30). In addition, the definition was applied identically to each of the study patients.

The consensus reported in the literature for primary treatment of calcific tendinitis of the shoulder is nonoperative therapy. Since evidence-based guidelines do not exist, physicians have no system for choosing the optimal type and duration of treatment from the variety of available options. The literature recommends a minimum of up to 6 months of nonoperative treatment, depending on the severity of the symptoms, before surgical intervention should be considered (19,30). In our cohort study, the mean symptomatic period was 3.9 years in the group of patients with failure of nonoperative therapy. Seil et al (19) performed arthroscopic removal of chronically symptomatic calcific deposits after a mean ± SD of 4.4 ± 3.3 years. Knowledge of the prognostic factors identified in this study can be used to optimize treatment in chronically symptomatic patients who are not responding to nonoperative therapy.

In addition, long-term symptomatic disease courses and potential complications (e.g., arthrofibrosis) could be avoided.

In conclusion, advanced therapeutic measures (e.g., needling, ESWT, arthroscopic removal of calcific deposits) should be considered in patients with persistent symptoms despite a minimum of 6 months of nonoperative symptomatic treatment who present with negative prognostic factors identified in our study: bilateral occurrence, localization at the anterior portion of the acromion, medial (subacromial) extension, and high volume of the calcific deposit.

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AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr. Maier had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study conception and design. Ogon, Suedkamp, Jaeger, Koestler, Maier.

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Analysis and interpretation of data. Ogon, Suedkamp, Jaeger, Izadpanah, Koestler, Maier, and Prof. Dr. Jürgen Schulte-Mönting (nonauthor).

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