Rotator cuff calcific tendinitis: another entity of rotator cuff problems

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Chapter 4

Prognostic factors for the outcome of needle aspiration of calcific deposits for rotator cuff calcific tendinitis

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Abstract

Objective

To identify prognostic factors for the effectiveness of needle aspiration of calcific deposits (NACD) for rotator cuff calcific tendinitis (RCCT).

Methods

One hundred forty-nine patients with symptomatic RCCT were included in a prospective cohort study. Pain (VAS), shoulder function (SST and DASH) and quality of life (EQ-5D) were assessed at baseline and at 3, 6 and 12 months post-NACD. Univariate analyses (independent t-tests or Mann-Whitney U tests depending on the distribution of data) were performed to build a multivariable linear regression model. Stepwise regression analysis through backward elimination was performed to evaluate the effect of predefined prognostic factors on the outcome.

Results

Patients who underwent multiple NACD procedures had less reduction of pain ($p<0.01$). Furthermore, a larger reduction in VAS pain scores at 3 months post-NACD was associated with a larger reduction in VAS pain scores at 12 months ($p<0.01$). More improvement of SST and DASH scores at 3 months were associated with better SST, DASH and EQ-5D scores at 12 months ($p<0.01$). Smaller-size calcific deposits were associated with less improvement of DASH ($p=0.03$) and EQ-5D scores ($p=0.01$). A longer duration of symptoms prior to NACD was associated with less improvement of EQ-5D scores ($p=0.01$).

Conclusions

A good initial response after NACD is associated with better outcomes at 12 months. Patients with a longer duration of symptoms prior to NACD and patients who require multiple procedures showed inferior outcomes in terms of pain reduction and improvement of quality of life. Smaller-size calcific deposits are associated with a less favorable outcome of shoulder function and quality of life scores and might therefore be less susceptible for NACD.

Introduction

Rotator cuff calcific tendinitis (RCCT) is a frequently diagnosed shoulder disease, which is found in up to 54% of patients with shoulder complaints[1]. It is suggested that RCCT is a self-limiting disease that can be treated with conservative measures (rest, non-steroidal anti-inflammatory drugs (NSAIDs) or physiotherapy)[2,3,4]. However, a substantial number of patients has persisting symptoms requiring other therapies such as subacromial injections with corticosteroids, needle aspiration of calcific deposits (NACD) or extracorporeal shockwave therapy (ESWT)[5]. A recently published meta-analysis comparing these therapies concluded that NACD is the most effective treatment considering relevant clinical outcomes within a follow-up term of two years[6]. However, up to 42% of patients experience persisting or recurrent shoulder complaints after NACD[7,8]. Female gender, smoking and type I calcifications according to the classification by Gärtner and Heyer are considered predictors for persisting shoulder complaints[7,9,10]. However, the majority of studies investigating prognostic factors for the effectiveness of NACD are retrospective and to our knowledge, no prospective studies investigating prognostic factors have been conducted. As more evidence is needed on this highly prevalent shoulder disease, we conducted a prospective cohort study to further identify prognostic factors for the effectiveness of NACD.

Materials and Methods

Study design and study population

A prospective cohort study was conducted at the departments of orthopaedic surgery and radiology. All consecutive patients referred to the department of radiology between October 2014 and August 2016 for the treatment of symptomatic RCCT were included. Inclusion criteria were clinical signs of calcific tendinitis defined as pain in the deltoid region worsening by elevation of the arm above the shoulder level and/or at night and the presence of calcific deposits on radiographs and/or ultrasound examination. Exclusion criteria were age <18 years, being unable to read and write the Dutch language, previous NACD treatment or surgery of the affected shoulder and the presence of other causes for shoulder complaints (e.g. full thickness tear of the rotator cuff, frozen shoulder). Only the treatment of the first shoulder was analyzed in patients who underwent bilateral treatment.

Since it was a prospective cohort study evaluating current treatment and follow-up standards of our department, the study was declared free from subject to the medical research involving human subjects act and the IRB approved the local study execution.

Data collection and outcome measures

After the participating patients signed informed consent forms, baseline data, including demographics and data related to the medical history and previous treatments, were collected.

Prior to the NACD procedure, baseline scores were completed by all patients: visual analogue scale for pain (VAS 0-100mm where 0mm represents 'no pain' and 100mm 'the worst pain ever possible'), the Simple Shoulder Test (SST; 0 (worst score) to 12 (best score)), the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH; 0 (no disability) to 100 (most severe disability)) and the EQ-5D (0 (worst score) to 1 (best score).

Every two weeks during the first ten weeks following the NACD procedure, patients reported a VAS pain score, whether they had physiotherapy and whether they had used analgesic medication (type and dose).

At three months, six months and one year after the NACD procedure, patients reported the VAS pain score, SST, DASH and EQ-5D questionnaires. Furthermore, the number of NACD procedures patients underwent was noted. The indication to perform a repeated NACD

procedure was persisting clinical symptoms of calcific tendinitis with calcific deposits on ultrasound examination in the absence of another cause for shoulder complaints (e.g. frozen shoulder, subacromial bursitis). A minimum period of six weeks between the first and second NACD procedure or the second and third NACD procedure was applied.

The primary endpoints were: reduction of pain at 12 months post-NACD (ΔVAS baseline-12 months); improvement of shoulder function at 12 months post-NACD (ΔSST baseline-12 months and ΔDASH baseline-12 months); improvement of quality of life (QoL) at 12 months post-NACD (ΔEQ-5D baseline-12months). Minimal clinically important differences (MCID; ≥14mm for VAS[11], ≥2.0 for SST[12], ≥10.83 for DASH[13] and ≥ 0.07 for EQ-5D[14]) were used to determine whether the reduction of pain and improvement of shoulder function and QoL were clinically relevant.

Radiographic assessment and technical procedure

All patients had both radiographic and ultrasound assessment of the affected shoulder prior to the NACD procedure.

Standard anteroposterior and axial radiographs were used to examine the size and number of calcific deposits and the affected tendon(s). Calcific deposits were categorized into three different types using the classification described by Gärtner and Heyer[9]: type I calcifications are dense with well-defined borders; type II calcifications are either dense with indistinct borders or transparent with well-defined borders and type III calcifications are transparent with indistinct borders. The location of the calcific deposits was determined based on the method used by Ogon et al.[3] in which negative values represent a medial calcification border.

Ultrasound was performed using a standardized protocol by experienced musculoskeletal radiologists. The size, the number of calcific deposits and the affected tendon(s) were recorded. Furthermore, the presence of subacromial bursitis, partial rotator cuff tears and subacromial impingement was assessed prior to the NACD procedure.

During the NACD procedure the consistency of the calcific deposits was assessed as either soft (toothpaste like) or hard. Furthermore, the possibility to aspirate the calcific deposit was reported.

Ultrasound-guided NACD was performed using a single needle technique with 20 or 21 gauge needle. After maneuvering the needle into the calcific deposit, the deposits was

infiltrated with lidocaine 1%, fragmented in case of a hard calcific deposit and removed by aspiration. After completing the aspiration, the subacromial bursa was infiltrated with 4 ml bupivacaine (2,5mg/ml; Aurobindo Pharma B.V) and 1ml kenacort (40mg/ml; Bristol-Myers Squibb B.V.). No specific rehabilitation program was prescribed.

Statistical analysis

Univariate analyses (independent t-tests in case of normally distributed data and the Mann-Whitney U tests in case the data was not normally distributed) were performed to build a multivariable linear regression model. Factors that approached a significant correlation ($p < 0.10$) were included for multivariable linear regression analysis.

Stepwise regression analysis through backward elimination was performed to determine factors associated with better reduction of pain, better improvement of shoulder function and better improvement of QoL. All the previously selected factors were entered into the equation after which the factor that contributed the least (i.e. highest p-value) was deleted. This process was continued until all factors in the equation had a significance level of $p < 0.05$.

All statistical analyses were performed using the statistical package SPSS version 20.0 (IBM).

Results

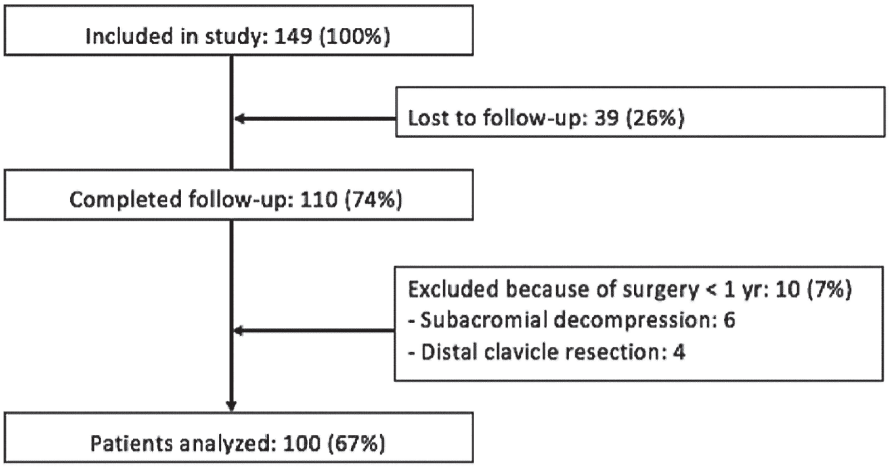

Figure 1: flowchart of patient inclusion and drop-out.

149 consecutive patients were included of which 39 patients were lost to follow-up as these patients did not complete the 12-month follow-up questionnaires (figure 1). The baseline characteristics of the patients included in this study are presented in table 1. The average duration of symptoms prior to NACD was 29 months and over one fifth of patients reported absenteeism from work due to shoulder complaints. The majority of patients underwent other therapies prior to the NACD procedure: over 75% of patients had physiotherapy and over 50% of patients already had subacromial injection(s) with corticosteroids.

Except for age (55yr in the analyzed group vs. 51yr in the drop-out group; p=0,016), none of the other demographic or baseline values differed significantly between these groups.

During the course of the study, 10 patients failed NACD treatment and had arthroscopic surgery due to persisting symptoms (Figure 1). In the patients requiring surgery, bilateral occurrence of RCCT was more common (5/10 vs. 20/100, Fisher's exact test $p<0.046$) and these 10 patients had less pain relief at three months post NACD compared to the non-failed group ((ΔVASbaseline-VAS3months 9mm vs. 33mm, independent t-test $p<0.043$). None of the other prognostic factors studied in this study differed significantly between patients that required surgery and those who did not.

During the NACD procedure successful aspiration of calcium was achieved in 51% (50/98 patients) of patients.

Table 1: Baseline characteristics	
Demographic details	
Male (%)	49 (45%)
Female (%)	61 (55%)
Age (SD;range)	54,9 (8,2; 36-77)
Medical history	
Duration of symptoms in months (SD; range)	29 (33; 1-120)
Bilateral occurence (%)	25 (22,7)
Dominant arm affected (%)	65 (59,1)
Heavy physical work (%)	50 (46,3)
Absenteeism from work due to shoulder complains (%)	23 (22,5)
Average amount of days of absenteeism from work (SD; range)	78 (99; 2-360)
Smoking (%)	21 (21)
Diabetes (%)	10 (10)
Previous treatment	
Analgesics (%)	69 (62,7)
Fysiotherapy (%)	84 (76,4)
Shockwave (%)	14 (12,7)
Subacromial injection (%)	59 (53,6)
Ultrasound findings	
Affected tendon(s)	
Supraspinatus (%)	103 (93,6)
Infraspinatus (%)	2 (1,8)
Subscapularis (%)	17 (15,5)
Subacromial bursitis (%)	19 (18,4)
Partial thickness rotator cuff tear (%)	27 (25,7)
Subacromial impingement (%)	8 (13,3)
Radiographic findings	
Size in mm (SD; range)	16,5 (9,4; 2,0-44,9)
Numer of calcific deposits	
One (%)	61 (59,8)
Multiple (%)	41 (40,2)
Gartner & Heyer classification	
Type I (%)	60 (58,2)
Type II (%)	29 (28,2)
Type III (%)	14 (13,6)

Table 1 (Continued)

Location according to Ogon et al. In mm (SD; range)	-6,4 (13,1; -36,1-26,4)
Features of AC osteoarthritis (%)	48 (44,4)
Post NACD	
Analgesics during first 6 weeks post NACD (%)	57 (56,4)
Fysiotherapie during first 6 weeks post NACD (%)	33 (33,0)
Average amount of physiotherapy visits (SD; range)	3,5 (2,5; 1-11)

SD: standard deviation

Improvement of pain, function and QoL at three, six and 12 months

At 12 months follow-up 83% (91/110) of patients had lower pain scores compared to their preintervention baseline score and 70% (77/110) of patient reached MCID. The average decrease of VAS scores was 31mm (SD 24.3).

With regard to function, respectively 74% (81/110) and 78% (86/110) of patients showed improved SST and DASH scores (average improvement SST 3.6 (SD 3.5); average improvement DASH 17.5 (SD 15.9)) and respectively 65% (72/110) and 64% (70/110) of patients reached MCID. QoL improved in 56% (62/110) of the patients and remained the same in 24% (26/110); 46% (51/110) of patients showed a clinical important improvement. The average improvement in EQ 5D was 0.12 (SD 0.26).

The largest decrease of pain, improvement of function and QoL was seen at three months following the NACD procedure after which the level of pain, shoulder function and QoL scores remained within the MCID interval (figure 2).

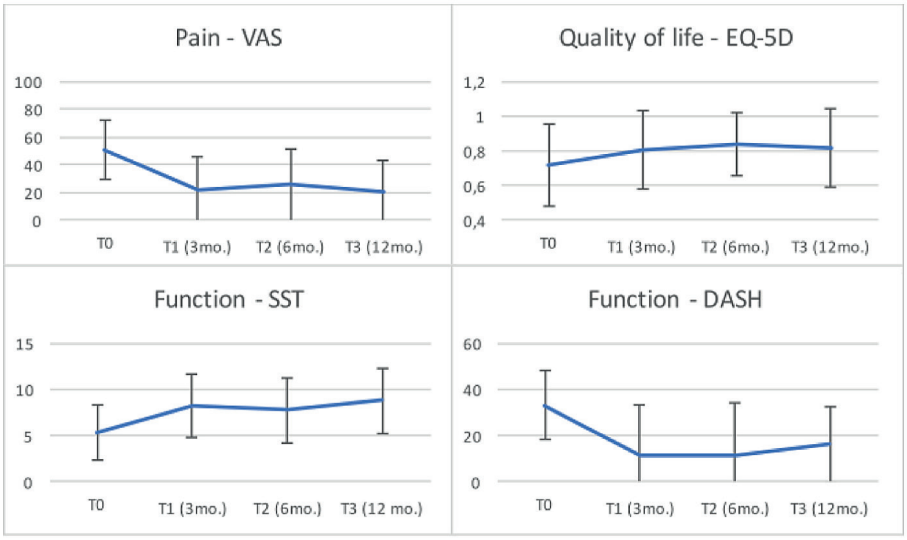

Figure 2: course of pain (VAS), shoulder function (SST and DASH) and QoL (EQ-5D) during the course of this study.

Factors associated with decrease of pain, improvement of shoulder function and improvement of QoL

A summary of the results of the univariate analyses for factors related to decrease of pain, improvement of shoulder function and QoL is presented in table 2. A complete overview of the results of the univariate analyses can be found in supplementary file I.

With regard to reduction of pain, multiple NACD procedures were associated with more pain 12 months after the intervention. A greater reduction of pain at three months after NACD was associated with more pain relief at 12 months (table 3). For the improvement of shoulder function and QoL, improved SST and DASH scores at three months were strongly associated with more improvement of the shoulder function and QoL at 12 months. A longer duration of symptoms prior to the NACD procedure was associated with less improvement of QoL. The size of the calcification was positively associated with DASH and QoL scores: larger-size calcific deposits showed better outcome at 12 months (table 3).

Table 2: Summary of univariate analyses for reduction of pain (VAS), improvement of shoulder function (SST and DASH) and improvement of QoL (EQ-5D).

	Factor		Value	p-value
Pain - VAS	Multiple NACD procedures	Mean difference (95% CI)	15,5mm (5,1 to 25,9mm)	0.004
	ΔVAS at three months	Pearson correlation coefficient (95% CI)	0,500 (0,327 to 0,674)	<0.001
	ΔDASH at three months	Pearson correlation coefficient (95% CI)	0,267 (0,074 to 0,461)	0.007
Function - SST	Size of calcific deposit	Pearson correlation coefficient (95% I)	0,232 (0,028 to 0,425)	0.029
	Multiple NACD procedures	Mean difference (95% CI)	1,8 (0,3 to 3,3)	0.023
	ΔSST at three months	Pearson correlation coefficient (95% CI)	0,362 (0,176 to 0,549)	<0.001
	ΔDASH at three months	Pearson correlation coefficient (95% CI)	0,282 (0,09 to 0,474)	0.004
Function - DASH	Absenteeism from work due to shoulder complaints	Mean difference (95% CI)	9,3 (-1,1 to 19,7)	0.078
	Analgesics use prior to the NACD procedure	Mean difference (95% CI)	5,6 (-0,4 to 11,6)	0.067
	Physiotherapy prior to the NACD procedure	Mean difference (95% CI)	8,6 (1,3 to 15,8)	0.021
	Subacromial impingement	Mean difference (95% CI)	11,1 (-0.9 to 23,1)	0.068
	Size of calcific deposit	Pearson correlation coefficient (95% CI)	0,225 (0,022 to 0,413)	0.031
	Multiple NACD procedures	Mean difference (95% CI)	8,2 (1,4 to 15,1)	0.019
	ΔSST at three months	Pearson correlation coefficient (95% CI)	0,267 (0,074 to 0,460)	0.007
	ΔDASH at three months	Pearson correlation coefficient (95% CI)	0,441 (0,261 to 0,621)	<0.001
Quality of life - EQ-5D	Duration of symptoms	Pearson correlation coefficient (95% CI)	0,246 (0,051 to 0,443)	0.026
	Size of calcific deposit	Pearson correlation coefficient (95% CI)	0,254 (0,052 to 0,452)	0.018
	Multiple NACD procedures	Mean difference (95% CI)	0,10 (-0,01 to 0,21)	0.088
	ΔSST at three months	Pearson correlation coefficient (95% CI)	0,262 (0,069 to 0,456)	0.008
	ΔDASH at three months	Pearson correlation coefficient (95% CI)	0,185 (-0,012 to 0,382)	0.063

CI: confidence interval. Mean differences were calculated using independent t-tests or Mann-Whitney U tests depending on the distribution of data.
Only factors with a p-value of 0.10 or less are presented in this table. For a complete overview of all factors, see supplementary file I.

Table 3: Results of multivariable regression analysis for reduction of pain (VAS), improvement of shoulder function (SST and DASH) and improvement of QoL (EQ-5D).

	Factor	Comparison	Regression coefficient (95% CI)	p-value
Pain - VAS	Number of NACD procedures	Multiple procedures vs. single procedure	-12.34 (-21.47 to -3.22)	0.009
	ΔVAS at three months	Per 1 mm	0.409 (0.262 to 0.555)	< 0.001
Function - SST	ΔSST at three months	Per point	0.258 (0.134 to 0.382)	< 0.001
	ΔDASH at three months	Per point	0.048 (0.019 to 0.078)	0.002
Function - DASH	ΔSST at three months	Per point	0.692 (0.124 to 1.26)	0.018
	ΔDASH at three months	Per point	0.323 (0.196 to 0.449)	< 0.001
	Size of calcific deposit	Per 1 mm increase in size	0,313 (0.028 to 0.598)	0.032
Quality of life - EQ-5D	Duration of symptoms	Per months increase of symptoms	-0.002 (-0.003 to 0.000)	0.012
	Size of calcific deposit	Per 1 mm increase in size	0.006 (0.001 to 0.011)	0.011
	ΔSST at three months	Per point	0.012 (0.003 to 0.022)	0.013
	ΔDASH at three months	Per point	0.003 (0.001 to 0.005)	0.013

Discussion

Our prospective study on clinical and radiographic predictors for the outcome after NACD for rotator cuff calcific tendinitis showed that the majority of patients had less pain and improvement of both shoulder function as well as quality of life (QoL) one year after NACD. A good initial response after NACD was associated with a better outcome at 12 months, whereas patients who required multiple procedures and patients with a longer duration of symptoms prior to the NACD procedure showed less favorable results. Furthermore, smaller size calcific deposits were associated with worse shoulder function outcome and less improvement of QoL.

In our study, 70% of patients had a clinical relevant decrease of VAS pain scores. Furthermore, 64% to 65% of patients showed clinically important improvement of shoulder function, respectively measured by the SST and DASH. In 46% of the patients QoL scores were clinically relevant improved at 1 year after NACD. The largest decrease in pain and improvement of shoulder function and QoL was seen at three months post-intervention after which the improvement seemed to stabilize (figure 2). A similar pattern of decrease in pain scores and improvement of shoulder function was found by Serafini et al.[15]; the largest decrease of pain and improvement of shoulder function was also seen after three months after which the level of pain and shoulder function stayed relatively stable to up to ten years of follow-up. The importance of this initial response to NACD seems to be one of the most important prognostic factors for a good outcome at one year. Thus, patients with less decrease of pain after NACD seem to have a higher likelihood of persisting pain at one year follow-up. Accordingly, patients with less improvement of the SST and DASH scores at three months report worse functional scores at one year follow-up. Thus, short-term results of NACD seem to be a good predictor for the long-term outcome which is useful in the evaluation of the treatment and in the management of patient expectations. This is a new finding compared to previous studies.

Prognostic factors for negative outcomes of NACD found in this study were multiple NACD procedures, smaller size calcific deposits and a longer duration of symptoms prior to NACD. The latter is a well-known negative prognostic factor which is supported by multiple studies[3,7].

Regarding the effects of multiple procedures on the outcome of NACD doubt could exist about if this variable represents a cause of bad prognosis or simply represents

the consequence of attempting the same procedure in non-responding patients. Studies on the effect of multiple procedure on the outcome of NACD are scarce and inconclusive. Farin et al., for example, found that the outcomes of second and third procedures were inferior to the outcome of the primary NACD procedure[16]. On the other hand, studies by del Cura et al. and Oudelaar et al. found no difference in outcome between shoulders that were treated once and those treated twice or even three times[8,17]. As the results of this study add evidence to the theory that the number of NACD procedures do negatively affect the outcome of NACD, physicians treating patients with RCCT should be aware of the inferior results of multiple procedures and should manage patient expectations likewise prior to a second NACD procedure.

With regard to the size of calcific deposits, larger size calcific deposits have been associated with worse outcomes in the conservative treatment of RCCT and after ESWT[3,18]. In NACD however, no such associations have been described. This study shows that smaller size calcific deposits are associated with less improvement of shoulder function. Smaller size calcific deposits are therefore perhaps less suitable for NACD. A possible explanation for these inferior outcomes is that shoulder complaints in patients with smaller size calcific deposits are most probable due to more complex inflammatory pathology and not due to a more localized post-inflammatory deposit of one or several “large” calcific deposits. Another explanation for the inferior outcome of NACD in smaller size calcific deposits could be that patients with smaller size calcific deposits have less complaints and are therefore less likely to demonstrate improvement. Additional in-depth analyses did however demonstrate that there was no correlation between baseline scores and the size of the calcific deposit (VAS: r=-0.35, p=0.738; SST: r=-0.149, p=0.153; DASH: r=0.099, p=0.345). It seems therefore unlikely that patients with smaller size calcific deposits have less complaints compared to patients with larger size calcific deposits which makes it more likely that the shoulder complaints in patients with smaller size calcific deposits have another cause, such as a more complex inflammatory pathology.

Calcific tendinitis is not always symptomatic as it is found in up to 35% of adults without shoulder complaints[19]. However, larger calcific deposits will sooner or later always result in shoulder complaints according to Bosworth et al.[19]. This statement is supported by a study by Louwerens et al. in which patients with calcific deposits of >1.5 cm in length had the highest chance of suffering from symptomatic calcific

tendinitis[20]. Based on the findings of this study and the mentioned literature, clinicians should be careful in attributing shoulder complaints to smaller size calcific deposits and be perhaps more cautious in referring for NACD as the outcomes in patients with smaller size calcific deposits are less favorable.

Earlier studies on prognostic factors for the effectiveness of NACD, which were all retrospective, found that smoking, female gender, dominant arm involvement, bilateral disease, longer duration of symptoms and multiple calcifications all were associated with less favorable outcomes[7,9,10]. Surprisingly, besides a longer duration of symptoms, none of these factors were associated with improvement of pain, shoulder function or QoL in this study. These differences can possibly be explained by a difference in outcome measures as a wide range of different outcome measures has been used such as the WORC, DASH and a binary scale which evaluated whether patients were free of complaints of not. More likely, the differences can be explained by a difference in the duration of follow-up. In a study by de Witte et al. for example, patients were followed-up after 14 years[7]. A substantial part of patients reported persisting shoulder complaints, but it is unclear whether the persisting shoulder complaints are due to persisting or recurrent RCCT or due to ageing (ie. degeneration of the rotator cuff)[21].

Twenty-eight possible prognostic factors for the outcome after NACD were evaluated of which only the size of the calcific deposit and the duration of symptoms prior to the intervention were associated with the outcome. Additionally, it is important to acknowledge that NACD is often performed after other therapies have failed. Even more important, little is known on the effect of these previous (failed) therapies on the perceived outcome of NACD. Results of this study demonstrate that previous unsuccessful treatments, in particular ESWT and subacromial injections with corticosteroids, did not affect the outcome of NACD. NACD is therefore also indicated after failure of other therapies for RCCT. Furthermore, other radiological findings such as AC osteoarthritis and partial thickness rotator cuff tears are often present in RCCT[22]. In the current study, these radiological findings did not affect the outcome of NACD and are therefore not a contraindication for NACD. Results of the current study also demonstrate that aspiration of the calcific deposit during the NACD procedure had no evident effect on the clinical outcome of NACD. In this study successful aspiration of calcium could be achieved in 51% of the patients using a 20- or 21-gauge needle. Only two other studies reported on the possibility of aspirating

calcium during the NACD procedure. Del Cura et al.[17] were able to aspirate calcium in 75% of patients using a 20-gauge needle whereas Aina et al.[23] reported successful aspiration in only 33% of patients using a 22 gauge needle. In literature a wide range of needle sizes has been reported varying from 18- to 22-gauge[23,25]. Larger size needles can facilitate the aspiration of calcium but might on the other hand damage the residual tendon fibers[23]. Current literature is inconclusive about the effect of aspiration of calcium during the NACD procedure on the outcome of NACD as the above-mentioned studies demonstrate conflicting results[17,23]. Results of this study demonstrate that successful aspiration of calcium during the NACD procedure is not a prerequisite for a good outcome.

This is the first prospective study evaluating prognostic factors for the effectiveness of NACD. Nevertheless, this study has several limitations. First, a relatively large number of patients (39 patients; 26%) was lost to follow-up at 12 months. However, a certain drop-out rate could be expected as others reported drop-out rates of 30% for web-based surveys[24]. Secondly, the study does not have a control group. Although it would have been ideal to have a control group to rule out that the outcome is because of the self-limiting history of RCCT, we believe that, for the purpose of identifying prognostic factors, a large prospective cohort study is of sufficient methodological quality. Finally, the follow-up term of this study was 1 year, this is comparable to other studies[16,17,25], but some long-term studies on RCCT show that a substantial part of patients still have persisting shoulder complaints in the long term[7,26]. More research is needed to gain insight in predictive factors for persisting shoulder complaints in the long term.

In conclusion, NACD provides early pain relief and improvement of shoulder function and quality of life. A good initial response to NACD is associated with a better outcome whereas a longer duration of symptoms prior to NACD, multiple NACD procedures and smaller size calcific deposits are associated with inferior outcomes.

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Supplementary file I: Univariate analyses for reduction of pain (VAS), improvement of shoulder function (SST and DASH) and improvement of QoL (EQ-5D).

	Pain		Function				Quality of life	
	diffVAS	p	diffSST	p	diffDASH	p	diffEQ-5D	p
Demographic details								
Gender (male vs. female)	2,9 (-6,9 to 12,7)	0,558	0,6 (-0,7 to 2,0)	0,360	-2,6 (-9,0 to 3,8)	0,426	0,05 (-0,06 to 0,15)	0,367
Age	-	0,793	-	0,443	-	0,361	-	0,145
Medical history								
Duration of symptoms in months	-	0,441	-	0,143	-	0,495	-	0,026*
Bilateral occurence	-9,5 (-21,8 to 2,8)	0,128	1,1 (-0,7 to 2,8)	0,240	-2,0 (-10,1 to 6,1)	0,626	-0,03 (-0,16 to 0,10)	0,599
Dominant arm affected	-2,6 (-12,6 to 7,4)	0,602	-0,5 (-2,0 to 0,9)	0,452	3,7 (-2,8 to 10,2)	0,263	-0,05 (-0,15 to 0,06)	0,373
Heavy physical work	3,1 (-6,9 to 13,1)	0,545	-0,2 (-1,6 to 1,3)	0,826	2,9 (-3,6 to 9,4)	0,380	0,03 (-0,08 to 0,13)	0,615
Absenteeism from work due to shoulder complaints	3,5 (-9,1 to 16,2)	0,582	-1,0 (-2,7 to 0,8)	0,271	9,3 (-1,1 to 19,7)	0,078*	0,01 (-0,12 to 0,14)	0,909
Smoking	1,8 (-10,8 to 14,4)	0,775	-0,6 (-2,4 to 1,3)	0,540	-0,9 (-9,5 to 7,8)	0,846	0,08 (-0,04 to 0,21)	0,189
Diabetes	-5,9 (-21,7 to 9,9)	0,457	1,5 (-0,8 to 3,8)	0,192	-8,9 (-19,6 to 1,9)	0,104	0,07 (-0,11 to 0,24)	0,414
Previous treatment								
Analgesics	4,3 (-5,7 to 14,2)	0,396	-0,9 (-2,2 to 0,4)	0,173	5,6 (-0,4 to 11,6)	0,067*	0,06 (-0,05 to 0,16)	0,282
Physiotherapy	8,1 (-3,1 to 19,3)	0,156	-0,8 (-2,4 to 0,8)	0,325	8,6 (1,3 to 15,8)	0,021*	-0,01 (-0,13 to 0,11)	0,837
Shockwave therapy	4,8 (-9,1 to 18,7)	0,495	0,3 (-1,7 to 2,3)	0,743	1,7 (-7,4 to 10,9)	0,711	-0,09 (-0,24 to 0,06)	0,215
Subacromial injection	3,6 (-6,1 to 13,3)	0,465	1,1 (-0,3 to 2,4)	0,132	-5,3 (-11,5 to 1,0)	0,100	-0,05 (-0,16 to 0,05)	0,310
Sonographic findings								
Subacromial bursitis	-3,7 (-16,5 to 9,0)	0,562	-0,5 (-2,3 to 1,4)	0,626	-2,3 (-8,6 to 4,0)	0,466	-0,08 (-0,22 to 0,07)	0,291
Partial thickness rotator cuff tear	7,0 (-3,9 to 17,9)	0,205	0,2 (-1,4 to 1,8)	0,795	1,3 (-6,1 to 8,6)	0,735	-0,01 (-0,13 to 0,11)	0,848
Subacromial impingement	14,2 (-4,2 to 32,7)	0,128	-1,8 (-4,3 to 0,7)	0,144	11,1 (-0.9 to 23,1)	0,068*	-0,08 (-0,28 to 0,12)	0,446

Supplementary file I (Continued)

Radiographic findings								
Size in mm	-	0,273	-	0,029*	-	0,031*	-	0,018*
Numer of calcific deposits (one vs. multiple)	-3,5 (-13,7 to 6,6)	0,492	0,5 (-1,0 to 2,0)	0,492	0,0 (-6,7 to 6,7)	0,991	0,01 (-0,11 to 0,12)	0,904
Gartner & Heyer classification								
Type I	29	0,375	-3,5	0,649	18	0,472	0,08	
Type II	37		-4,1		19		0,16	0,391
Type III	30		-3,3		13		0,08	
Location according to Ogon et al. In mm	-	0,982	-	0,651	-	0,591	-	0,517
Features of AC osteoarthrosis	-6,3 (-16,1 to 3,6)	0,207	0,3 (-1,2 to 1,7)	0,733	-2,8 (-9,3 to 3,7)	0,390	-0,04 (-0,14 to 0,07)	0,466
Findings during NACD								
Aspiration of calficic deposit during procedure	-0,2 (-10,1 to 9,8)	0,975	0,5 (-0,9 to 1,9)	0,475	-1,7 (-8,2 to 4,8)	0,614	0,07 (-0,04 to 0,17)	0,196
Post NACD								
Analgesics during first 6 weeks post NACD	5,9 (-4,4 to 16,3)	0,259	-0,9 (-2,3 to 0,7)	0,250	4,4 (-2,3 to 11,1)	0,195	-0,08 (-0,20 to 0,03)	0,141
Physiotherapy during first 6 weeks post NACD	7,2 (-3,8 to 18,2)	0,199	-1,0 (-2,6 to 0,6)	0,208	4,8 (-2,3 to 12,0)	0,183	0,07 (-0,06 to 0,18)	0,320
Number of NACD procedures								
One vs. multiple procedures	15,5 (5,1 to 25,9))	<0,01*	1,8 (0,3 to 3,3)	0,023*	8,2 (1,4 to 15,1)	0,019*	0,10 (-0,01 to 0,21)	0,088*
Results 3 months postNACD								
DiffVAS	-	<0,01*	-	0,265	-	0,316	-	0,150
DiffSST	-	0,118	-	<0,01*	-	<0,01*	-	0,005*
DiffDASH	-	<0,01*	-	<0,01*	-	<0,01*	-	0,063*

Average differences are presented with the 95% confidence interval within the parentheses. -: no average difference could be presented as correlation coefficients were calculated. *: p<0.10 and hence inclusion in multivariate analysis.