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ORIGINAL ARTICLE

PREDICTORS OF FUNCTIONAL RECOVERY IN PATIENTS WITH ROTATOR CUFF CALCIFIC TENDINOPATHY UNDERGOING US-GUIDED PERCUTANEOUS LITHOCLASY: A RETROSPECTIVE STUDY

Barbara Meoni[1], Julieta Giacani[1], Anna Chiara Ficai[2], Marika Montano[2], Marco Baccini[1], Giovanni D'Elia[3], Filippo Vittadini[4], Antonio Frizziero[5], Francesca Cecchi[2,6]

[1] IRCCS Fondazione don Carlo Gnocchi, Florence, Italy
[2] Postgraduate School of Physical and Rehabilitation Medicine, University of Florence, Florence, Italy
[3] Azienda Ospedaliera Universitaria Careggi, Florence, Italy
[4] Department of Physical and Rehabilitative Medicine, Casa di Cura Giovanni XXIII, Monastier Treviso, Italy
[5] Department of Physical and Rehabilitative Medicine, ASST "Gaetano Pini" CTO, Milan, Italy
[6] Department of Physical and Rehabilitation Medicine, University of Florence, Italy

Corresponding author's e-mail: antonio.frizziero@asst-pini-cto.it

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ABSTRACT

Background and aim: US-guided percutaneous irrigation (US-PICT) is a treatment option for rotator cuff calcific tendinopathy (RCCT). This secondary analysis of a prospective study was aimed to identify short-, medium, and long-term predictors of response to US-PICT.

Methods: Subjects with symptomatic RCCT and calcium deposit >5 mm undergoing US-PICT were included. Changes in outcome measures at different time points were analyzed using Friedman ANOVA. Univariate and multivariate analyses evaluated predictors (age, gender, technique –one/two needle–, intra-procedural calcific outflow, calcification size and grade, post-procedure rehabilitation) of clinical outcomes (change from baseline assessment in pain at rest and on movement, Constant-Murley Score, Oxford Shoulder Score) at one, three, six and twelve months.

Results: Overall, 162 patients (169 shoulders) were included. Significant improvements in pain and function were found one month after UGPL ($p < 0.001$) and retained at 12 months. Worse baseline clinical scores were the strongest predictors of improvements, with R^2 ranging 0.469-0.992 at 12-months assessment. Calcification size and Farin grade explained a minimal additional variance at one or more follow-ups.

Conclusions: US-PICT is safe and effective in both the short term and the long term, and baseline severity is the main predictor of improvement in pain and function after the procedure.

KEYWORDS

Calcific tendinopathy, functional predictors, rotator cuff, ultra-sound-guided percutaneous irrigation

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INTRODUCTION

Rotator cuff calcific tendinopathy (RCCT) is a common source of shoulder pain[1]. The pathogenesis is not fully elucidated; however, it is recognized as a multifactorial condition in which metabolic and hormonal factors and ageing may play a central role[2,3]. It mainly affects individuals aged 30 to 60 years with a prevalence about 1.5 times higher in women[4].

The deposit of calcium-hydroxyapatite crystals is due to a three-stage mechanism characterized in the first phase by fibrocartilage metaplasia of the tenocytes driven by *Human Leukocyte Antigens 1* (HLA1), with a consequent increase in the production of proteoglycans and the formation of fibrocartilage tissue[5]. During the second phase, the calcium-hydroxyapatite crystals are deposited in vesicles, creating identifiable regions of deposition devoid of vascularization. In the last stage, the resorptive process, increase in neovascularization is observed with macrophages and multinucleated giant cells that surround the calcific tissue[6].

The spread and technological improvement of ultrasound (US) has radically changed the diagnosis and therapeutic approach of RCCT. Conservative treatment should always be proposed, while full agreement has not yet been reached on the procedures. Extracorporeal shock-waves (ESWT) and US-guided percutaneous irrigation of calcific tendinopathy (US-PICT) have both demonstrated important clinical results and could be considered as feasible options[7,8]. The latter has the advantage of allowing complete disaggregation of calcification in a rapid procedure in comparison to ESWT, although some needle-related adverse effects have been reported, including infections, bleeding/hematoma, vascular nerve injuries, tendon injuries, allergic reactions to drugs, systemic reactions to corticosteroids, persistent pain and, in the medium to long term, serous or fibro-adhesive bursitis on a reactive inflammatory basis or the persistence of residues of the original calcification[8].

However, there are insufficient findings about the predictive factors of functional recovery after US-PICT. The previous studies that evaluated this important aspect of the procedure present several limitations in sample size, choice of outcome measures and imaging variabilities[9-12].

Therefore, the primary objective of the present study is to identify the prognostic and predictive factors for the clinical outcome in patients undergoing US-PICT.

MATERIAL AND METHODS

Study design

This is a secondary analysis of the database collected for a prospective study already published in 2021 and aimed to evaluate the effects of physiotherapy after US-PICT[13], to which three patients were added whose follow-up assessment had not yet been conducted at the time of the previous analysis. Further, additional data from a 12-month follow-up were included. This retrospective analysis of medical records was approved by the local Ethical Committee on 04/02/2025 (register number 27819_oss). The database is owned by the Careggi University Hospital where the data was collected from 2012 to 2016.

162 patients were included, of whom 7 were treated bilaterally for a total sample of 169 treatments. *Table 1* shows the demographic and clinical characteristics of participants, and data related to procedure and post-procedure physiotherapy. The average age was 50.53 years (SD 7.85), with high prevalence of women. The target shoulder was more frequently the right one. Farin grade II and III were both more than twice as high as grade I. The symptoms at t0 were characterized by severe shoulder pain during movement rather than at rest, with a moderate to severe functional impairment. The procedure was

Age in years, mean (SD), range	50.53 (7.85), 24-73
Gender, n (%)	
Men	45 (27.8)
Women	117 (72.2)
Shoulder undergoing the procedure, n (%)	
Right	96 (59.3)
Left	59 (36.4))
Both	7(4.3)
Calcification	
Size. mean (SD), range	16.2 (5.60), 7-30
Farin grade I, n (%)	30 (17.8)
Farin grade II, n (%)	78 (46.2)
Farin grade III, n (%)	61 (36.1)
Severity at baseline, mean (SD), range	
Pain at rest, NRS 0-10	2.9 (3.3), 0-10
Pain on movement, NRS 0-10	8.2 (1.8), 3-10
Oxford Shoulder Score	21.7 (11.7), 0-48
Constant-Murley Score	39.1 (23.7), 2-100
Data related to procedure, n (%)	
One needle technique	109 (64.5)
Two needles technique	60 (35.5)
Calcific outflow	118 (69.8)
Reoperation	45 (26.6)
Post-procedure physiotherapy, n (%)	86 (50.9)

Table 1. *Characteristics of participants (N = 162 with a total of 169 shoulders undergoing the procedure).*

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conducted with single-needle technique in about 2/3 of interventions, and intraprocedural calcium material leakage occurred in a similar percentage. Only about half of the patients chose to undergo standard physiotherapy after the procedure.

In all participants, concomitant diseases, the affected tendon status, localization and size of calcification were evaluated. The calcific deposits were classified in one of the three stages according to Farin classification[14], depending on the amount of calcium contained in the deposit:

- Type I, hyperechoic foci with precise limits and well-defined acoustic shadowing, like a gallstone (formative phase);
- Type II hyperechoic foci with blurred limits and faint posterior shadow cone;
- Type III hyper/isoechogenic formations.

Only patients who presented symptomatic (pain ≥4 as measured by a 0-10 Numerical Rating Scale, NRS) RCCT with calcium deposits >5 mm identified by US evaluation and classified according to Farin were included. Exclusion criteria were: partial or total rotator cuff tear, other shoulder pathologies (i.e. fractures, arthritis, active infections), coagulation disorders or taking oral anticoagulant drugs, insertional calcification (enthesopathy), calcification already partially or totally disrupted in the context of the tendon fibers.

Outcome measures

The outcome measures were:

- *Constant-Murley Score (CMS):* It is based on two subjective measures (pain intensity and impact of pain on activities of daily living) and two objective measures (range of motion and muscle strength). The maximum score is 100, which represents the best shoulder function. The CMS has been shown to have acceptable reliability, especially when administered by the same rater[15], and has been validated in Italian[16]. A systematic review[17] assessed all the metric properties of the CMS in various shoulder conditions using the EMPRO (Evaluating Measures of Patient Reported Outcomes) tool and found an acceptable score for use in subjects with subacromial pathology.
- *Oxford Shoulder Score (OSS):* it is a multi-item self-assessment questionnaire for completion by patients having shoulder surgery, consisting of twelve multiple choice questions with five response options (from 0 to 4) investigating the difficulties encountered during activities of daily living due to shoulder pain[18]. The maximum score is 48, which indicates the lowest difficulty. A validated Italian version of this scale is also available[19].
- *NRS for pain:* it is a widely used method for the assessment of pain, that has been shown to have acceptable reliability in patients with shoulder pain[20]. Participants were asked to rate their perceived pain at rest (Pain_rest) and during active shoulder movements (Pain_mov) using a scale from 0 to 10, where 0 indicates no pain and 10 indicates maximum pain.

Each patient was evaluated by the same physiatrist at T0 (the same day just before US-PICT), and one (t1), three (t2), six (t3) and twelve (t4) months after US-PICT treatment. The Constant-Murley score, however, was not collected at T1. At each follow-up, US assessment was used to check the evolution of the pathology. Any relapses of symptoms were also recorded, as well as the occurrence of a re-intervention within the period of follow-up (12 months).

US-guided procedure

The US-PICT was performed after US evaluation of the shoulder, according to the guidelines issued by the European Society of Musculoskeletal Radiology and describe in a previous study[13]. With patient laying on the bed (supine or on his/her side) an US-guided injection of local anesthesia (100–200 mg of 1% lidocaine chloridrate) into the subacromial-subdeltoid bursa and in subcutaneous tissues was given under sterile conditions. One or two 16–18 G needles were inserted inside the calcification under continuous US monitoring with a free-hand technique based on calcification size and Farin stage. Saline solution (NaCl 0.9%) was injected using a 10 ml-syringe to dissolve the internal calcification by the propulsion and aspiration of the syringe plunger (one needle technique) or to create a liquid circuit injected from a needle and drained by the other (two needles technique). The occurrence of calcific material out-flow during the procedure (yes/no) was noted. The procedure was stopped when calcification was completely collapsed. Finally, an anti-inflammatory steroid medication (40 mg of methylprednisolone acetate) was injected in the subacromial-subdeltoid bursa under direct US-guidance. After the treatment, all the patients were recommended to rest and refrain from lifting weights for at least 5–7 days. They were also offered standard physiotherapy treatment, but many preferred to perform the recommended exercises at home on their own.

Statistical analysis

The distribution of the data was preliminarily verified using the Shapiro-Wilk test. Since all measures were not normally distributed, non-parametric tests were subsequently used.

Subjects who requested a re-intervention after the first follow-up were compared with others in terms of age, gender, tendinopathy (size of calcification, Farin grade), procedure (one or two needles; calcified material leakage), standard physiotherapy performed after the procedure and baseline assessment using the Kruskal-Wallis test or chi-square test, as appropriate. The same comparisons were conducted among participants who were treated with US-PICT using one or two needles.

Changes in the outcome measures at the different time points were analyzed using the Friedman ANOVA,

followed by Conover's pairwise comparisons. Participants who requested a new intervention were excluded from this analysis, except for the two who were treated again prior to the first follow-up, since for them the timing of the follow-ups was rescheduled based on the date of the new intervention. Since 13 participants were not assessed at t4, the analysis was conducted both excluding (N = 127) and including (N = 114) this time point.

In the analysis of variables that were associated with the outcome at each follow-up assessment, measured as changes from T0, data of participants who underwent a re-intervention before the date of the assessment were excluded. In the univariate analysis, the association of each outcome at different follow-ups (i.e. changes from baseline assessment measured at t1, t2, t3 and t4) with numerical variables (age and size of the calcification) was investigated using the Spearman's correlation, whereas differences related to categorial variables (gender, Farin classification, US-PICT procedure –one/two needles–, intra-procedure outflow of calcific material –yes/no–, physiotherapy after the procedure –yes/no) were verified using the Kruskal-Wallis test. The variables found to be associated with the outcome were then included as independent variables in linear regression models, together with the value of the outcome measured at t0.

RESULTS

In about 1/4 of subjects (N = 44), follow-up ultrasound examination revealed the presence of serous or fibroadhesive bursitis or the persistence of residual calcification, with persistent pain at different follow-ups, indicating the need for reoperation (new intrabursal cortisone injection or new US-PICT). Specifically, 2, 17, 20 and 5 patients underwent re-intervention before the 1-, 3-, 6-, and 12-month follow-ups, respectively.

No differences were found between participants who requested and those who did not request re-intervention in terms of age (p = 0.857), gender (p = 0.600), calcification size (p = 0.131), Farin grade (p = 0.093) and number of needles used (p = 0.146); however, they showed more severe impairments at the baseline assessment in most outcome measures, that were significant only for OSS (Pain_rest: p = 0.059; Pain_mov: p = 0.449; CMS: p = 0.073; OSS: p = 0.035). Moreover, they more frequently exhibited intra-procedural outflow of calcific material (35/42 vs 83/127; p = 0.028) and more frequently underwent standard physiotherapy after the procedure (28/42 vs 58/127; p = 0.018). In the multivariate analysis, however, only undergoing physiotherapy remained significantly associated to the occurrence of re-intervention.

The US-PICT procedure was conducted using one and two needles in 109 and 60 interventions, respectively. Participants who were treated with two needles were less frequently women than those treated with one needle (37/60 vs 85/109, p = 0.024) and had significantly greater calcification (p = 0.001), more severe pain (Pain_rest, p = 0.016; Pain_mov, p = 0.041) and greater impairment of upper limb function (CMS, p <0.001; OSS, p = 0.021) at baseline assessment. No differences were found between the two groups in terms of age, Farin grade of calcific tendinopathy, intra-procedural outflow, affected side or physiotherapy after the procedure.

In participants who did not undergo re-intervention after the first follow-up and with complete data at all follow-

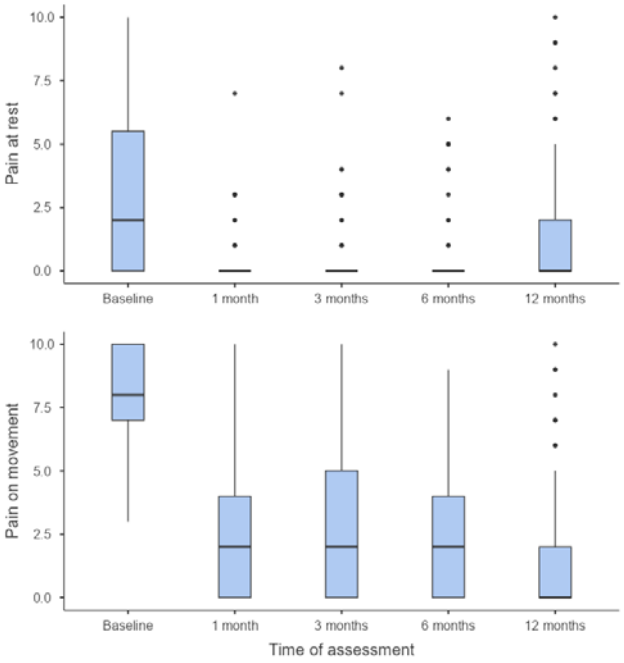


Figure 1. *Severity of pain perceived at rest (Pain_rest) and during shoulder active movement (Pain_mov) at different time points (minimum, first quartile, median, third quartile, maximum).*

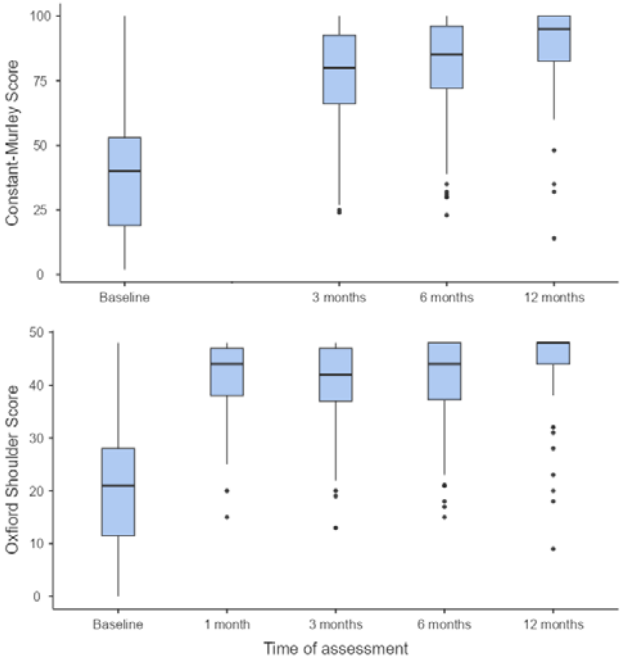


Figure 2. *Impairment of upper limb function as measured by clinical scales at different time points (minimum, first quartile, median, third quartile, maximum).*

Abbreviations: OSS, Oxford Shoulder Score; CMS, Constant-Murley Score.

ups (N = 114), Friedman's ANOVA showed significant improvements (p <0.001) in both pain *(Fig. 1)* and function *(Fig. 2)*. According to post-hoc analysis, Pain_rest and Pain_mov were significantly reduced –and Pain rest even eliminated in most participants– as early as one month after the procedure, and then remained unchanged at all subsequent follow-ups, except for a slight but significant increase in Pain_mov at t3 which was followed by a further reduction at subsequent follow-ups. Pain_mov at t12 was significantly lower than at all previous assessments. Upper limb function, measured using CMS and OSS, had also improved significantly at t1, with further improvements at subsequent follow-ups. Results were unchanged when the analysis was conducted including data of 127 subjects who completed the 1-, 3- and 6-months follow-ups.

The results of the univariate analyses are shown in *Table 2 and 3*. Whereas age was never associated with the outcome at any follow-up, the size of the calcification showed a significant correlation with most outcomes *(Table 3)*. Among categorical variables, no effect of calcific material outflow was found at any follow-up, whereas the use of physiotherapy after the procedure was associated

	Pain_rest	Pain_mov	CMS	OSS
Age				
Change at t1 (N = 169)	0.046	-0.108	NR	-0.085
Change at t2 (N = 152)	0.024	-0.139	0.026	-0.054
Change at t3 (N = 134)	-0.001	-0.047	-0.024	-0.100
Change at t4 (N = 114)	0.000	-0.021	-0.046	-0.081
Size of calcification				
Change at t1 (N = 169)	0.136	**0.163***	NR	**0.305*****
Change at t2 (N = 152)	0.158	**0.169***	**0.300*****	**0.343*****
Change at t3 (N = 134)	0.096	**0.338*****	**0.325*****	**0.365*****
Change at t4 (N = 114)	0.047	**0.309*****	**0.310*****	**0.337*****

Table 2. *Spearman's correlation of numerical variables with changes in the four outcomes as measured at different follow-ups compared to baseline (significant correlations in bold).*

** p <0.05; ** p <0.01; *** p <0.001; Abbreviations: NR, not recorded; CMS, Constant-Murley Score; OSS, Oxford Shoulder Score.*

	Pain_rest	Pain_mov	CMS	OSS
Gender				
Change at t1 (N = 169)	**0.003**	0.518	NR	0.233
Change at t2 (N = 152)	**0.007**	0.412	0.967	0.430
Change at t3 (N = 134)	**0.003**	0.140	0.496	0.853
Change at t4 (N = 114)	**0.035**	0.784	0.543	0.314
Outflow (yes-no)				
Change at t1 (N = 169)	0.487	0.354	NR	0.422
Change at t2 (N = 152)	0.572	0.737	0.857	0.544
Change at t3 (N = 134)	0.649	0.918	0.803	0.648
Change at t4 (N = 114)	0.941	0.342	0.358	0.234
Physiotherapy (yes-no)				
Change at t1 (N = 169)	0.735	**0.007**	NR	0.054
Change at t2 (N = 152)	0.412	0.467	0.636	0.505
Change at t3 (N = 134)	0.180	0.957	0.202	0.697
Change at t4 (N = 114)	0.309	0.319	0.131	0.911
Number of needles (1-2)				
Change at t1 (N = 169)	**0.030**	**0.006**	NR10	**0.005**
Change at t2 (N = 152)	0.126	**0.007**	**0.002**	**0.002**
Change at t3 (N = 134)	0.347	**0.001**	**<0.001**	**0.011**
Change at t4 (N = 114)	0.161	**0.035**	**0.004**	0.055
Farin grade (1-2-3)				
Change at t1 (N = 169)	0.183	0.259	NR	**0.004****
Change at t2 (N = 152)	**0.037****	**<0.001****	**<0.001*****	**0.001*****
Change at t3 (N = 134)	0.060	**0.039****	**<0.001*****	**0.001****
Change at t4 (N = 114)	0.339	0.090	**0.002***	**0.011****

Table 3. *Effect of categorical variables to changes measured in the four outcomes at different follow-ups compared to baseline (Kruskal-Wallis test, p-value; significant differences in bold).*

** Farin 3 > Farin 2 and Farin 1; ** Farin 3 > Farin 1; *** Farin 3 > Farin 2 and Farin 1; Farin 2 > Farin 1; Abbreviations: NR, not recorded; CMS, Constant-Murley Score; OSS, Oxford Shoulder Score.*

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with a significantly lower decrease in Pain_mov at t1 (p = 0.007) and a non-significantly lower OSS score (p = 0.054). Differences between males and females were found in Pain_rest, with females reporting greater pain in all follow-ups. In contrast, significant differences were found in most outcomes when comparing participants with different Farin grade, with significantly greater improvements in Farin 3 than in grade 2 and grade 1, and when comparing participants who were treated using one or two needles, with the latter showing greater improvements.

The results of multivariate analysis are shown in *Tables 4-7*. For all outcome measures, the value of that measure at baseline was the main predictor of improvement, but other variables often explained an additional, albeit minimal, portion of the total variance. In detail, the effect of Farin grade was found significant in the model for change in Pain_rest and OSS at t2, change in Pain_mov and CMS at t2 and t3 (higher grades associated with higher change in the outcome), whereas the size of calcification was significant in the model for change in Pain_mov at t2, t3 and t4, change in CMS at t12 and change in CMS at all follow-ups. In the multivariate analysis, the procedure technique was unrelated to any outcome.

DISCUSSION

Our findings confirm that US-PICT is reproducible, safe, and effective for the treatment of RCCT both for the one- and two-needle technique, in accordance with the

Model	N	R	R^2	Corrected R^2	F	p
1-month*	169	.932	.869	.868	559	<0.001
3-months**	152	.906	.821	.816	169	<0.001
6-months***	134	.950	.902	.900	596	<0.001
12-months****	114	.996	.992	.992	6830	<0.001

Table 4. *Linear regression models with pain at rest (Pain_rest) as dependent variable. Asterisks indicate predictors that were significantly related to the outcome.*

**Pain_rest at baseline (β = 0.932, p <0.001). **Pain_rest at baseline (β = 0.880, p <0.001), Farin grade 3-1 (β = 0.210, p = 0.045). ***Pain_rest at baseline (β = 0.936, p <0.001), gender (β = 0.127, p =0.047). ****Pain_rest at baseline (β = 0.998, p <0.001).*

Model	N	R	R^2	Corrected R^2	F	p
1-month*	169	.385	.148	.128	7.14	<0.001
3-months**	152	.573	.328	.305	14.3	<0.001
6-months***	134	.645	.416	.393	18.1	<0.001
12-months****	114	.695	.483	.469	34.3	<0.001

Table 5. *Linear regression models with pain on movement (Pain_mov) as dependent variable. Asterisks indicate predictors that were significantly related to the outcome.*

**Pain_mov at baseline (β = 0.332, p <0.001). **Pain_mov at baseline (β = 0.414, p <0.001), Farin grade 3-1 (β = 0.702, p <0.001), size (β = 0.151, p = 0.045). ***Pain_mov at baseline (β = 0.516, p <0.001), Farin grade 3-1 (β = 0.438, p = 0.038), size (β = 0.193, p = 0.012). ****Pain_mov at baseline (β = 0.631, p <0.001), size (β = 0.260, p <0.001).*

Model	N	R	R^2	Corrected R^2	F	p
3-months*	152	.777	.603	.590	44.7	<0.001
6-months**	134	.819	.671	.658	51.7	<0.001
12-months***	114	.875	.766	.755	70.8	<0.001

Table 6. *Linear regression models with Constant Murley Score (CMS) as dependent variable. Asterisks indicate predictors that were significantly related to the outcome.*

**CMS at baseline (β = 0.679, p<0.001), Farin grade 3-1 (β = 0.532, p = 0.001), grade 2-1 (β = 0.312, p = 0.041). **CMS at baseline (β = 0.712, p <0.001), Farin grade 3-1 (β = 0.373, p = 0.023). ***CMS at baseline (β = 0.823, p <0.001), size (β = 0.134, p = 0.011).*

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Model	N	R	R^2	Corrected R^2	F	p
1-month*	169	.807	.652	.641	61.0	<0.001
3-months**	152	.809	.654	.642	55.6	<0.001
6-months***	134	.849	.720	.709	65.3	<0.001
12-months****	114	.896	.802	.795	110	<0.001

Table 7. *Linear regression models with Oxford Shoulder Score (OSS) as dependent variable. Asterisks indicate predictors that were significantly related to the outcome.*
**OSS at baseline (β = 0.760, p <001), size (β = 0.111, p = 0.033). **OSS at baseline (β = 0.703, p <0.001), Farin grade 3-1 (β = 0.474, p = 0.002), 2-1 (β = 0.327, p = 0.022), size (β = 0.129, p = 0.018). ***OSS at baseline (β = 0.779, p <0.001), size (β = 0.154, p = 0.004). ****OSS at baseline (β = 0.845, p <0.001), size (β = 0.128, p = 0.006).*

European Society of Musculoskeletal Radiology Delphi study (ESSR)[21].

Our study primarily investigated the possible impact of different predictive factors and outcome measures. The size of calcification and higher pain at baseline were significant related to good response to the procedure.

In a systematic review, Lanza et al. observed that the studies are heterogenous both for outcomes measuring and treatment modalities, while the Authors observed that the Constant-Murley score, could be considered a valid outcome measure and therefore proposed as a standard method for further studies[22]. Compared with Lanza et al.[22], that evaluated prognostic and predictive factors in the long term, our analysis aims to assess short-to-medium term prognostic and predictive factors, that are not deepened investigated previously[23].

In Evangelia et al.[23], a correlation between greater calcification size with low pain perceived at baseline and improvement in pain both in the short- and long-term follow-up was found. We observed direct relation between calcification size and good response to the treatment, while we showed a correlation between greater pain symptoms at baseline and a greater reduction in pain both at rest and on movement especially after treatment with the two-needle technique, which is maintained at 6 months follow-up. The better scores on bigger calcifications could also been related to technique limitations. Small calcifications may be more difficult to be targeted and treated during the lavage procedure.

Our findings could be explained considering that more intense pain symptoms at baseline indicate that the calcification is most likely in the reabsorption phase[24], in which it is becoming softer (or colliquated) and therefore easier to intrude with one or two needles. Furthermore, the use of the two-needle technique permits a continuous flow of saline solution which helps to remove a greater quantity of calcium material and to precisely control the local pressure induced by the saline solution during the procedure[22,25]. Nevertheless, in the multivariate analysis, the number of needles used in the procedure was not significantly associated to any outcome, most likely because the size of calcification was the prevailing factor.

As to the effects of physiotherapy, all patients were asked to perform a physiotherapy program within the first month after US-PICT. However, based on personal circumstances or preferences (occupational activities, free time available, distance from the physiotherapy center), only some of the patients underwent physiotherapy. Since undergoing physiotherapy was based on personal choice, we cannot rule out the possibility that at least some patients chose to do so when they were still experiencing pain or limitations in the weeks/days following US-PICT. Physiotherapy may have been chosen only when it was most appropriate, which could explain why this variable was found to be insignificant in our analyses. However, it is also possible that the anti-inflammatory and antalgic corticosteroid coverage masked the independent antalgic effects of physiotherapy at t1 and t2. On the other hand, since the corticosteroid coverage might also mask comorbidities (i.e. impingement syndrome) that may contraindicate some type of exercises in the early subacute phase, and since physiotherapy was associated with a higher share of relapses after the US procedure, it is also possible that, as suggested in the previous paper[13], physiotherapy should be best considered only for patients who have relapsed of pain after three months, to treat associated conditions such as scapulohumeral dyskinesia, postural alterations and the same impingement syndrome in the late subacute phase.

We chose to use ultrasound to evaluate the evolution of the pathology at each follow-up visit, while previous studies are not uniform for the imaging tool used at follow-up[22,23]. Our study is the first to our knowledge in which each US evaluation was performed by the same skilled operator that reported both the size and the Farin stage classification for each patient and not only qualitative description of the calcification itself as previously found[23,26].

Finally, our findings indicate that US-PICT could be efficient in the most painful phase of RCCT and that higher pain at rest and at movement could be considered a positive prognostic factor. The most painful phase should correspond to the resorptive phase of the calcification or the grade II/III in Farin classification and we speculate

that the main indication of US-PICT is this phase of the pathology.

This is an observational study with the inherent limitations of such a study design, so all results must be confirmed in adequately-powered randomised trials.

CONCLUSION

US-PICT is safe and effective even in the short term as improvement of both pain and shoulder function can be detected as early as one month after the procedure, and improvements are retained in the long-term. Factors significantly associated with the extent of improvement are greater pain and functional impairment at baseline and, to a lesser extent, larger calcification size and Farin stage III.

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