

# Shoulder adhesive capsulitis, treatment with oxygen ozone: Technique and results

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## Abstract

Adhesive capsulitis of the shoulder, also known as frozen shoulder, is a condition characterized by a reduction in the arc of active and passive motion of the joint in the presence of essentially normal radiographic tests, except for the possible finding of osteopenia or calcific tendinitis. It is a condition with an uncertain etiology, characterized by the spontaneous onset of pain. From March 2015 to March 2016, 10 patients with adhesive capsulitis were treated with a cycle of intra-articular and subcutaneous infiltrations. Of these, 6 patients were female, of 49.3 average age (min 40 - max 59) and 4 male, and 4 were male, of 56.7 average age (min 48 - max 65); the average age of all participants was 52.3 (min 40 - max 65). The dominant limb was affected in seven cases, while in three, the non-dominant limb was affected. Oxygen-ozone treatment in adhesive capsulitis proved to be extremely effective; the absence of side effects has proven the safety of its use. A comparison with other types of treatment demonstrates a similar, and perhaps greater efficacy with no risks and side effects such as are present in the others. Further studies are necessary to confirm the validity of this technique.

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## Introduction

Adhesive capsulitis of the shoulder, also known as frozen shoulder, is a condition characterized by a reduction in the arc of active and passive motion of the joint in the presence of essentially

normal radiographic tests, except for the possible finding of osteopenia or calcific tendinitis.<sup>1</sup> It is a condition with an uncertain etiology, characterized by the spontaneous onset of pain.

It is one of the most common and yet less understood pathologies of the glenohumeral joint; this is linked to the fact that there is difficulty in defining it and clearly differentiating it from other conditions with similar symptoms and signs, but with clearly different causes.

It occurs in 2-5% of the general population,<sup>2-4</sup> predominantly among women, most commonly between the ages of 40 and 60.<sup>5-7</sup>

Commonly, this pathology is considered as a self-limiting condition with a natural history that lasts from 1 to 3 years;<sup>8</sup> in some cases, however, a refractory course is reported, with persistent pain and/or movement limitation, in 15-50% of patients undergoing conservative treatment.<sup>9,10</sup>

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## Classification

It is commonly divided into a primitive (idiopathic) and a secondary form. Recently, a post-surgical and post-traumatic variety has been added to these two types<sup>11,12</sup> (Table 1).

The primitive form includes all cases in which the origin cannot be traced to other known causes. These are, therefore, the forms that arise without apparent reason in an otherwise healthy individual.<sup>12</sup>

In the secondary form, rather, we find some predisposing factors or at least the basis of the pathological process. It is thus defined based on the association with a known pathology. This may be intrinsic, extrinsic, or systemic.<sup>12</sup>

The intrinsic cases are based on an internal shoulder injury, such tendonitis or a rotator cuff lesion, a pathology of the long head of the biceps (LHB), calcific tendonitis, and acromioclavicular arthritis.<sup>12</sup>

The extrinsic cases involve structures external to articulation such as fractures of the clavicle, of the humerus, of the scapula, a prolonged immobilization of the upper limb resulting from trauma,<sup>12</sup> cardiac pathologies, such as ischemic heart disease and myocardial infarction, and pulmonary disease (emphysema, chronic bronchitis, tuberculosis and tumors),<sup>12</sup> cervical discopathy,<sup>7</sup> cerebrovascular accidents (CVA) with motor paralysis of the upper limb,<sup>13</sup> Parkinson's Disease,<sup>13</sup> cardiac catheterization through the brachial artery,<sup>14</sup> and cardiac surgery.<sup>15</sup>

The systemic cases report diabetes mellitus as one of the most frequent causes, with a course that is sometimes different from other primitive or secondary forms and with an often incomplete treatment response.<sup>5,7,16,17</sup> Thyroid dysfunction, particularly hypothyroidism, is also related to this pathology;<sup>18</sup> even hypoadrenalism, arterial hypertension, and dyslipidemia are concausal factors.<sup>19,20</sup>

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Finally, the tertiary forms that develop after an operation or a fracture; in particular, post-surgical forms can be more resistant to both conservative and surgical treatment and therefore require greater attention.<sup>12</sup>

Regarding the evolution of the pathology, four stages have been identified by Hannafin and Chiaia Stage 1 occurs in the first three months of the disease, with pain and minimal or no reduction of movement. Arthroscopic evaluation shows diffuse synovitis of the antero-superior capsule; stage 2, or freezing stage, occurs between 3 and 9 months from the onset, and is characterized by pain, with reduction of movement both while awake and while sleeping, with diffuse synovitis at arthroscopy; stage 3, or frozen stage, between 9 and 15 months, is characterized by minimal pain at extreme degrees of movement, which is however considerably reduced and stops stiffly. Arthroscopy shows a thickened, fibrous capsule, without hypervascularization; stage 4, or thawing, occurs between 15 and 24 months with almost negligible pain and with progressive improvement of mobility until completely subsiding (Table 2).

### Pathological anatomy

The articulation of the shoulder is very complex and occurs on several levels.

It is a combination of movements that occur between the glenohumeral and the scapulothoracic joints with a ratio of 2:1.

To allow its complete amplitude, essential for normal functioning of the shoulder, an intrinsic instability is required, ensured by a loose and wide capsule, whose surface area is twice that of the humeral head.

In order to guarantee stability, capsular thickenings are present forming the superior, middle, and inferior (anterior and posterior) glenohumeral ligaments; the rotator cuff tendons reinforce the capsule anteriorly, superiorly and posteriorly.

Upon arthroscopic examination, it is possible to find synovial recesses, in the anterior area between the superior glenohumeral

ligament and the middle one, known as the subscapular recess, in the posterior area just slightly deeper than the infraspinatus, is the infraspinatus recess; to its inferior, there is a lower recess that forms a fold similar to a hammock, stretched between the inferior anterior and posterior glenohumeral ligament, most evident upon adduction of the arm.

The loss of laxity and elasticity of capsular ligament tissues, with the loss of capsular recesses, is the basis for the reduction in movement that occurs in adhesive capsulitis.

Unfortunately, the etiology and the pathophysiological mechanism leading to the onset of this pathology are not well known.<sup>22-24</sup>

The primary sites of localization of the pathological process in adhesive capsulitis are the capsular tissue of the rotator cuff interval, with the coracohumeral ligament, and the axillary recess; there is precisely a thickening and a retraction of these structures; subsequently, the process may extend to the whole capsule.<sup>6,25,26</sup>

Likely there is a progressive pathological process, from a synovial inflammation to capsular fibrosis, where the former is responsible for pain and the second for the reduction of movement with stiffness.<sup>22,27-29</sup> Rodeo *et al.*<sup>27</sup> report that a hypervascular synovial hyperplasia is present in the initial phases, and results in a possible fibrosis of the subsynovial layer and of the capsule.

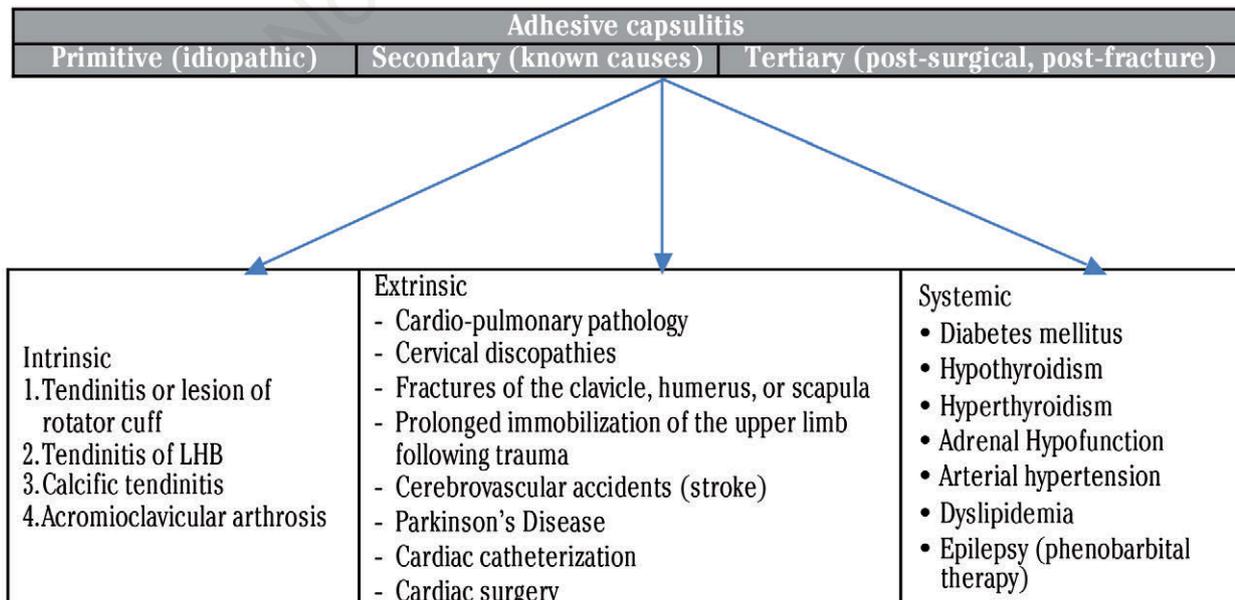
Recently, *in vitro* studies, in which samples from patients with adhesive capsulitis have been used, have focused on determining both the immunological basis for the development of the pathology and the role of cell signals and mediators of inflammation in its development.<sup>6,27,28,29</sup>

However, at the moment, there is little understanding of the etiology and the pathological mechanisms underlying the process.

Kim *et al.*,<sup>4</sup> in a study on rats of 2016, reproduced the onset of adhesive capsulitis by immobilizing the shoulder of the animals for three days, with a molded plaster apparatus, 1, 2, 3, 4, 5, 6 weeks, sacrificing them sequentially and analyzing the samples of the capsule to have an exact verification of the development process of adhesive capsulitis.

After one week, there was already a reduction in the angle of adduction; from a histological point of view, after only three days, the disappearance of the synovial folds, and of the subsynovial adi-

Table 1. Classification of Adhesive capsulitis.



pose tissue, infiltration of inflammatory cells, proliferation of capillaries in the subsynovial tissue, and capsular thickening was noted. After one week, the subsynovial adipose tissue had almost disappeared and the capsular thickening was beginning to be visible. At two weeks, the synovial and subsynovial tissue facing the humerus adhered to the bone, while the infiltration of the inflammatory cells, still present, was however diminished, and the fibrosis was dominant. Masson's trichrome stain showed that fibrosis began after three days and reached maturity at three weeks. There is, therefore, an initial phase of inflammation, with cell infiltration that is reduced after two weeks, while fibrosis progressively grows, reaching its peak after three weeks.

Histological and immunohistochemical examination of biopsy samples taken shows vascularized tissue and collagen with high cellularity, mainly composed of fibroblasts and myofibroblasts; this process is very similar to what occurs in the Dupuytren's contracture of the hand.<sup>30</sup>

A 2013 study by Lho *et al.*,<sup>22</sup> highlights the increase in inflammatory cytokines (IL-a, TNF-a), of COX-2 in both the joint capsule, and the subacromial recess, while TNF-a and IL-6 were increased in the joint fluid.

The high incidence of adhesive capsulitis in diabetic patients has given rise to speculative hypotheses on the biochemical rationale behind the process. High blood glucose levels are thought to lead to a faster rate of collagen glycosylation and cross-linking into the capsule, which would also underlie Dupuytren's contracture, which also has a high incidence in diabetic patients.<sup>31,32</sup>

## Clinical and diagnostic evaluation

The majority of patients with adhesive capsulitis are referred to a Doctor after weeks or months after the beginning of symptoms, normally when function starts to decrease significantly.

The onset is always insidious, usually progressive, sometimes after a somewhat moderate trauma or effort.

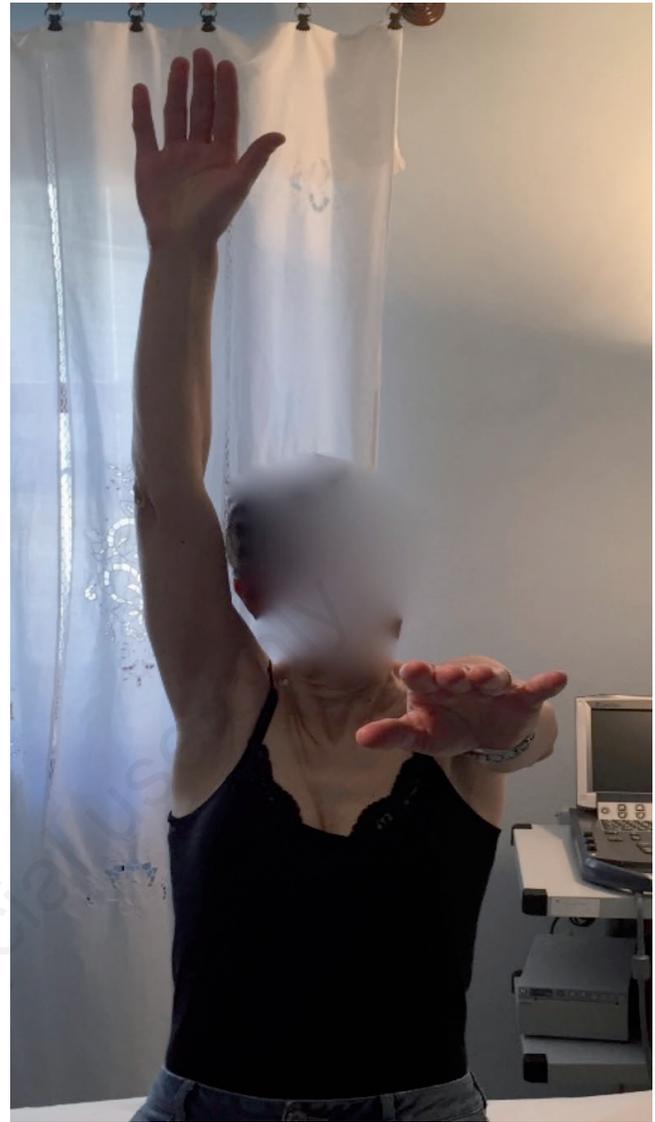
The pain is mainly nocturnal, making it hard to find a comfortable position, and is resistant to treatment with non-steroidal anti-inflammatory drugs.

Upon objective examination, there is a limitation of the anterior elevation, which does not exceed 120° (Figure 1), while the external rotation is reduced by half (Figure 2). Upon palpation, there may be tenderness to pressure of the anterior capsule (particularly at the rotator cuff interval), posterior capsule, and the distal insertion site of the deltoid on the humerus.

The diagnosis is preeminently clinical and is easily reached with the medical history and particularly with the objective examination. From a testing point of view, it is important to perform an X-ray to exclude the presence of glenohumeral arthrosis, which can limit the amplitude of the movement, or a posterior dislocation, which also blocks external rotation, and a good part of any front elevation. Traditional radiology will also provide useful information on the presence of osteopenia,<sup>33</sup> calcifications in the

**Table 2. Stages of Adhesive capsulitis.**

Stage 1: Pain; first three months of illness
Stage 2: Freezing; 3-9 months from the onset
Stage 3: Frozen; between 9 and 15 months
Stage 4: Thawing; between 15 and 24 months



**Figure 1. Front elevation reduced on the left.**



**Figure 2. External rotation reduced on the left.**

rotator cuff, a humeral-acromial conflict, or acromioclavicular arthritis.

Another useful test is the Magnetic Resonance that can reveal the presence of injuries of the tendons of the cuff, tendinopathy of the long head of the biceps, synovitis, or intraarticular effusion. It will also be possible to highlight the presence of any thickening of the joint capsule typical of the more advanced stages of capsulitis.<sup>34</sup> Any arthro-MR will demonstrate, with greater precision, the reduction of capsular volume, particularly of the axillary recess.<sup>35,36</sup>

## Treatment

Traditional treatment of adhesive capsulitis involves conservative therapy, followed by more invasive procedures in resistant cases (Table 3). The level of evidence of the various studies is however limited, due to the difficulty in defining etiology with certainty, and the fact that the patients seek treatment at various stages of the disease. The purpose of the various treatments is, however, to eliminate pain and recover movement, therefore acceptable function, within the shortest possible time.

Among *conservative treatments* there are non-steroidal anti-inflammatory drugs; however, a significant effect in improving pain and function has never been demonstrated.

The use of oral corticosteroids has shown a significant reduction of pain, particularly at night, and rapid recovery of movement.<sup>37-39</sup>

Intraarticular or subacromial area infiltration is commonly used, with results comparable to physiotherapy or more invasive measures such as manipulation under anesthesia or capsule hydrodilatation.<sup>40-42</sup>

Physiotherapy and *stretching* are universally accepted in the conservative treatment of such pathology, with good results in terms of resolution of symptoms.<sup>43</sup>

Hydrodilatation also seems to offer excellent results, better than manipulations for release under anesthesia, which involve a greater amount of time.<sup>44</sup>

Recent work on the use of acupuncture in adhesive capsulitis shows good results at three months on the recovery of articulation, above all elevation, and adduction, and on the Visual Analogue Scale of pain.<sup>45</sup>

Among *invasive treatments* we find manipulation under anesthesia, and surgical release.

Release under anesthesia consists in carrying out manipulations of the joint under general anesthesia, in order to free the movement of the shoulder. During manipulation there is a perception of a breakdown of tissues, very similar to the sensation felt when a Velcro is torn. Comparative studies, however, did not show

significant benefits compared to patients treated with physiotherapy<sup>46</sup> or hydrodistension.<sup>44</sup> On the contrary, with such treatment, complications such as fractures of the humerus, fractures of the glenoid, lesions of the ligaments, or avulsion of the glenoid, or injuries of the tendons of the cuff are common, thus this method is currently not recommended.

Arthroscopic capsular release is currently the treatment of choice in cases resistant to conservative therapy; this allows, after careful inspection and under direct control, a 360° capsular release, with the release of the thickened and retracted parts. Then there will be an immediate recovery of movement, and resolution of the painful symptoms. Further, such treatment also allows highlighting lesions associated with tendons or intra-articular structures with the possibility of proceeding to their treatment (Figure 3).

Traditional open air surgical treatment has now been superseded by the arthroscopic technique that allows for a better evaluation and complete 360° treatment.

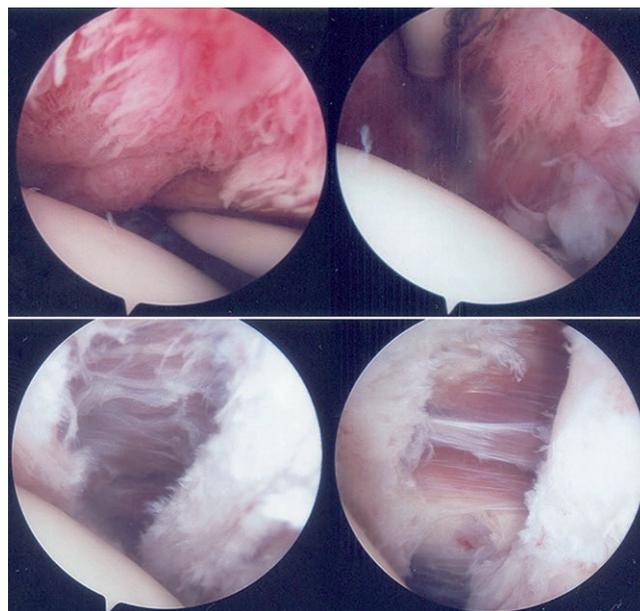
## Treatment with oxygen-ozone: rationale, technique

Oxygen-ozone treatment, which uses a mixture of 95-96% oxygen and 4-5% ozone, can be useful in different forms of adhesive capsulitis. As we have seen earlier, in this pathology there is a phase of inflammation of the joint capsule, with intense pain, which progresses with fibrosis of the same (very similar to that present in Dupuytren's contracture); the latter causes tissue retraction with reduction of shoulder articulation.

Among the various actions of ozone, there is a modulation and reduction of inflammation activity, and a reduction of pain with various mechanisms. Local injection of oxygen-ozone inactivates and destroys algogenic substances (oxidizing prostaglandins), inactivates bradykinin and other peptides, alters the serotonin, which has an indole nucleus, produces degradation of extracellular

**Table 3. Treatments of Adhesive capsulitis.**

Conservative treatment	Non-invasive treatment
NSAIDs	Manipulation under anesthesia
Oral corticosteroid therapy	Release under arthroscopy
Corticosteroid infiltrations	Surgical release
Physiotherapy	
Hydrodilatation	
Acupuncture	



**Figure 3. Top boxes: hyperemia and capsular retraction; bottom boxes: outcome of the release with opening of the capsule and viewing of the underlying subscapularis muscle.**

ATP, and transforms interleukins. All the above-mentioned substances are then modified so that they can no longer produce pain. There is also a release of antagonists, or soluble receptors, which neutralize proinflammatory cytokines, such as interleukins (IL-1, IL-2, IL-8, IL-12, IL-15), interferon- $\alpha$ , and TNF- $\alpha$ .

Finally, the denaturation of cellular proteins that produce algogenic substances such as COX, kininogen, kallikrein, occurs. It also modifies pain receptors and forms endorphins onsite.

Another activity of considerable importance is given by the decontracting and muscle relaxant action by direct action on the muscle fibers.<sup>47-51</sup>

Based on these assumptions, therefore, its use in the treatment of adhesive capsulitis is appropriate.

Pregnancy, latent hypoglycemia, hyperthyroidism, favism and sickle cell anemia, were considered for contraindications to treatment. It was also evaluated whether any lipomas were present in the areas to be treated due to the risk of embolism caused by the presence of arteriovenous shunts in such neoformations.

All patients were informed about the type of treatment, the characteristics of oxygen-ozone therapy, possible complications, therapeutic alternatives, and signed a consensus.

With regard to technique, Oxygen-Ozone Multioxygen Medical 99 I.R. Equipment was used (EC Marked by a Body notified by the Ministry of Health pursuant to Directive 93/42/EEC as amended and supplemented, Italian Legislative Decree 46/97 as amended and supplemented in class 2 A) (Figure 4).

Regarding Ozone concentrations and methods of administration, strict compliance with the protocols issued by the SIOOT [Oxygen Ozone Therapy Scientific Association], was implemented.

A 10 cc syringe, a 30-mm 23G needle, and a 4-mm 30G needle were used for collection and administration (Figure 5). In each ses-

sion, intra-articular infiltration and multiple subcutaneous infiltrations were performed at pre-established points. Eight to ten sessions were performed with a frequency of one per week.

For intra-articular infiltrations, the posterior access was used (Figure 6), after thorough disinfection with povidone-iodine solution, with a 30 mm 23G needle. The dosage used in the first session was 7mg/ml, infiltrating 7 cc. In the following sessions, 10 mg/ml were used, always infiltrating 7 cc, and gradually increasing to 15mg/ml.

Subcutaneous infiltrations were performed on predetermined points (Figure 7A and B), where pain and tenderness are usually reported. For this purpose a 4 mm 30G needle was used, infiltrating 3-5 cc per point for a total of 20-40 cc per session. At the end of the infiltrations, a massage was performed, with ozonized cream, in order to obtain a good diffusion and deep penetration of the ozone.

## Patients

From March 2015 to March 2016, 10 patients with adhesive capsulitis were treated with a cycle of intra-articular and subcutaneous infiltrations.

Of these, 6 patients were female, of 49.3 average age (min 40 - max 59) and 4 males, of 56.7 average age (min 48 - max 65); the average age of all participants was 52.3 (min 40 - max 65). The dominant limb was affected in seven cases, while in three, the non-dominant limb was affected.

Regarding the etiology in three subjects it was a primitive form, in one case, it was secondary in a diabetic subject, in one patient it was secondary to calcific tendinitis in diabetes, in another patient it was secondary to calcific tendinitis, subjected to two ultrasound-guided percutaneous lithotrophic sessions in cervicalgia and fibromyalgia, in four patients it was persistent capsulitis



Figure 4. Oxygen-ozone therapy equipment.



Figure 5. 10 cc syringe and 30 mm with 23G needle, and 4 mm with 30G needle was used.

after arthroscopic arthrolysis in diabetic patients, of which a female subject underwent arthrolysis and removal of intramedullary nail in fracture sequelae of the 3rd medial humerus, suffering from insulin-dependent diabetes (Table 4).

Subjects were assessed at the beginning of treatment, at the end and six months after the end of treatment (Table 4). In the evaluation the Visual Analogue Scale (Figure 8) for pain and the Constant score (Table 5), normalized by age, sex and side (Table 6), for the overall assessment of the shoulder.<sup>52</sup>

It is interesting to note that before treatment, the pain was strong, settling on an average value of 8 on the VAS scale, with a low Constant score of 32.5 (min 26.6 - max 38.8), while at the end of the treatment, the value of the VAS scale had fallen to 1.9 with a Constant score of 74.7 (min 68.8 - max 78.4). After six months from the end of treatment, there was a further improvement with a regression of painful symptoms, VAS 1, and remarkable recovery of functionality, Constant score 92.4 (min 82.3 - max 98.6).

No significant complications occurred in this group of patients. The only adverse event was the onset of significant pain, in the first few minutes after intra-articular infiltration, in the first two to three sessions, but which subsided after about five minutes.

## Discussion

Adhesive capsulitis is a very complex and insidious pathology, highly disabling for patients, who also experience very intense pain symptoms. Pain significantly reduces the quality of life, manifesting itself insistently during rest periods, which are severely disrupted. Work activity is compromised with further significant damage.

Although it is a pathology that tends to resolve spontaneously, its duration is still long reaching over 24-30 months, with a subsequent persistence of symptoms, with regard to pain and limitation of movement, which may affect 15-50 % of subjects.

The execution of an effective therapy is therefore essential to shorten the period of the disease and reduce any residual consequences as much as possible.

Among the various treatments available to us, oral or infiltrative corticosteroid therapy, as we have seen, can provide excellent

results. However, it must be considered that it can still have significant side effects and it is not always well-tolerated by patients. Moreover, often patients with diabetes will incur greater difficulties and risks in carrying out both the oral and infiltrative treatment. Their use can in fact cause decompensation with an increase in glucose values; in infiltrative therapy, in addition to the previ-



Figure 6. Posterior access.

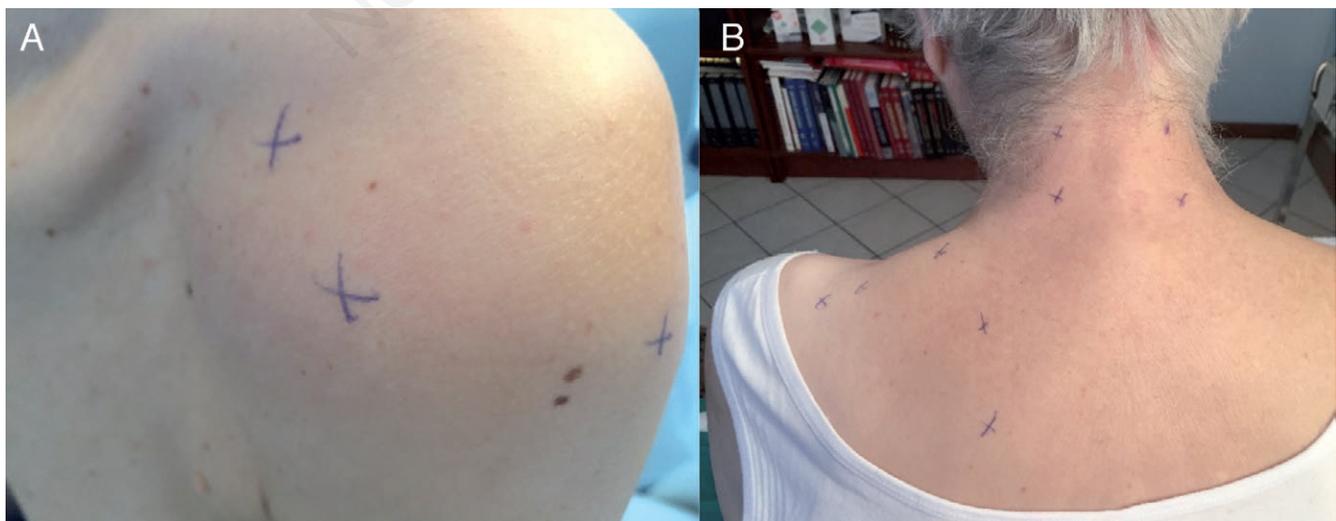


Figure 7. A) anterior and lateral subcutaneous points; B) posterior subcutaneous points.

ously mentioned issue, there will also be an increased risk of the onset of joint infections. Moreover, often, when treatment is discontinued, symptoms can relapse.

Physiotherapy can be an effective treatment, with good results reported in medical literature, nevertheless, particularly in the early stages where pain and inflammation are greater, it is difficult to implement. In fact, the attempt to mobilize accentuates the pain symptoms and, due to a reflex arc, very often increases inflammation and consequent stiffness. We believe it can be very useful, but during a second phase, when pain and inflammation have already been reduced and, in any case, with concomitant treatments.

Acupuncture, which has no side effects and improves symptoms, also seems to provide promising results. Further studies are therefore needed to validate its usefulness.

Arthrolysis and arthroscopy release provide excellent results for pain resolution and recovery of movement, particularly in

primitive forms. However, this is an invasive treatment that cannot be used as an initial treatment. Furthermore, particularly in surgical sequelae and in diabetic patients, it may sometimes be difficult to achieve complete recovery.

In my case studies, particularly in diabetic patients and in one post-surgical fracture case, there was a persistence of pain and stiffness.

Even as shown in medical literature, post-traumatic and post-surgical cases are always the most difficult to treat. In the above-mentioned cases, in fact we face retractions of very significant tissues, with persistent residual inflammation, nuanced frameworks of algoneurodystrophy and latent neurological pain.

In many cases there is also chronic pain, in trauma, surgery, and prolonged immobilization sequelae, with alteration of pain receptors.

In diabetic patients, progression is always complicated, with a high incidence of recurrence or persistence of pain, with resistance to treatment.

Another important fact, which is constantly found, is the presence of a considerable muscle contracture, with pain and tenderness upon palpation, affecting the trapezius, the levator scapulae muscle, small and large rhomboids and the cervical and dorsal paravertebral muscles. This can be linked to a postural alteration, a protective tendency, and an increased tension that leads to keeping the muscles in contraction mode. This fact contributes to feeding and accentuating the pain.

The use of ozone, thanks to its ability to reduce and modulate inflammation, to destroy the algogenic substances, to modify pain receptors, to improve microcirculation, and to produce a muscle relaxant action, has allowed to greatly improve the symptoms and the functionality of shoulders in such patients, allowing for a faster recovery and return to activities.

The analysis of the case studies shows us that there was a considerable reduction in pain already at the end of the treatment, which was subsequently maintained at the six-month follow-up, as evidenced by the analysis of the Visual Analogue Scale for pain.

The improvement of the Constant score also shows that there



Figure 8. VAS pain scale.

Table 4. Patients.

Subject Sex Side	Age	Etiology	No. of Sessions	Costant initial score	Initial VAS	End of treatment Costant score	End of treatment VAS	6-month Costant score	VAS at 6 months
1 F Right	Age: 59	Primitive	10	36.6	9	74.6	2	98.6	1
2 F Left	Age: 55	Primitive	10	33.8	8	76	1	97.1	1
3 F Left	Age: 43	Primitive	10	28.2	9	78.4	3	93.6	1
4 M Left	Age: 48	Diabetes	10	28.1	8	68.8	2	85.4	1
5 F Right	Age: 54	Calcific tendinitis, percutaneous lithotripsy, cervicalgia, fibromyalgia	10	26.6	9	77.3	2	93.3	1
6 F Right	Age: 40	Calcific tendinitis, diabetes	8	33.3	8	73.3	2	94.4	1
7 M Right	Age: 65	Persistent after arthrolysis in diabetes	10	31.3	9	73.5	2	89.1	1
8 M Right	Age: 52	Persistent after arthrolysis in diabetes	10	31.9	6	69.1	2	93.6	1
9 M Right	Age: 62	Persistent after arthrolysis in diabetes	8	36.1	7	78.3	2	96.3	1
10 F Right	Age: 45	Persistent after arthrolysis and removal of the nail in sequelae of a humeral fracture in insulin-dependent juvenile diabetes	8	38.8	7	77.6	1	82.3	1
Average value	52.3 (min 40 - max 65)			32.5 (min 26.6 - max 38.8)	8 (min 6 - max 9)	74.7 (min 68.8 - max 78.4)	1.9 (min 1 - max 3)	92.4 (min 82.3 - max 98.6)	1

was an essentially complete functional recovery from an initial value of 32.5 to a final value of 92.4.

Another important fact is that, in addition to very low-level invasion, there were no significant side effects. This fact made the treatment very well-tolerated by patients.

This study has many limitations because it is a limited case study, and extremely inhomogeneous. However, it can be the basis on which to carry out more targeted studies, on a greater number of patients and with better scientific and statistical criteria. This study has indeed made it possible to demonstrate the effectiveness and safety of this method, which could allow its use on a larger scale.

Table 5. Constant score.

Item	Score
Pain	15
None	15
Mild	10
Moderate	5
Severe	0
Activities of daily living	20
Full work	4
Full recreation/sports	4
Unaffected sleep	2
Hand position	
up to waist	2
up to xiphoid	4
up to top of head	8
above head	10
Range of motion	40
Abduction	10
Forward elevation	10
Int. rotation	10
Ext. rotation	10
Shoulder power	25
Pounds to resist	
Total	100

Table 6. Constant score normalized by age, sex, and side.

Age	Male subjects				Female subjects			
	Right	Left	Mean	SD	Right	Left	Mean	SD
21-30 y	97	99	98	4.2	98	96	97	4.7
31-40 y	97	90	93	3.4	90	91	90	4.1
41-50 y	86	96	92	3.6	85	78	80	3.8
51-60 y	94	87	90	3.1	75	71	73	2.8
61-70 y	83	83	83	4.2	70	68	70	4.0
71-80 y	76	73	75	3.6	71	64	69	3.9
81-90 y	70	61	66	3.1	65	64	64	2.9
91-100 y	60	54	56	4.3	58	50	52	5.1

## Conclusions

Oxygen-ozone treatment in adhesive capsulitis proved to be extremely effective; the absence of side effects has proven the safety of its use. A comparison with other types of treatment demonstrates a similar, and perhaps greater efficacy with no risks and side effects such as are present in the others.

A fundamental aspect is the use of equipment certified and recognized by the Ministry for the production of oxygen-ozone, compliance with the protocols of the SIOOT, and scrupulousness in the execution of infiltrations as regards a sterile environment and the type of material used.

Further studies are necessary to confirm the validity of this technique.

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