Pain management in the rehabilitation of stiff shoulder: Prospective multicenter comparative study of 193 cases


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KEYWORDS
Stiff shoulder; Treatment; Rehabilitation; Self-rehabilitation; Capsulotomy; Pain management; Adhesive capsulitis; Frozen shoulder; Complex regional pain syndrome; Therapeutic education

Summary

Introduction: The present study investigated the impact of respecting pain threshold on clinical recovery in stiff shoulder.

Patients and methods: A prospective multicenter comparative study followed up 193 cases of shoulder stiffness for a mean 12-month period (range, 8–31 months) after four different treatment protocols: (1) conventional sub-pain-threshold rehabilitation (58 cases); (2) self-rehabilitation exceeding the pain threshold (59 cases); (3) supervised suprathreshold rehabilitation (31 cases); and (4) capsulotomy with sub-threshold rehabilitation (45 cases). Follow-up was daily for the first 6 weeks then weekly for the next 6; each session included assessment of the painfulness, feasibility and duration of each rehabilitation and self-rehabilitation exercise and of pain status, disability and psychological status. The surgeon followed patients up at 6 weeks, 3 months, 6 months, 1 year and at last follow-up.

Results: Sub-threshold rehabilitation provided progressive results, limited in time (P < 0.05). Suprathreshold self-rehabilitation provided reduced pain (P < 0.05) as of the first days, with nocturnal pain ceasing after 7 days' rehabilitation in 43% of cases. Supervision of self-rehabilitation exercises optimized the clinical result (P < 0.05). Capsulotomy did not influence pain evolution over the first 8 weeks, but then improved it. Failure (at 1 year, 14–17%; last follow-up, 3.5%) correlated directly with the number of exercises performed by the patient (P < 0.05).
Introduction

Pain is an extra item on our care list; it is a fact, experienced by the patient but often difficult for the physician to deal with, and which strongly impacts every aspect of care, partly determining its conditions and results. Pain felt by the patient may affect our decisions and the quality of our treatment processes and, thus, of our results. Pain does not exist in itself: it is the painful experience that is the reality we have to deal with. “Pain is something else, it is inhuman” [1,2]. Pain is the felt result of a state of suffering for which we can only look for the mental or physiological conditions that have given rise to it [3]. The problem is to integrate this subjective datum, with its great potential variability, into the objective and statistical management of clinical assessment [4]. Rehabilitation exercises are painful, and our everyday practice works with the paradox of causing pain in order to alleviate it.

History in general, and the history of medicine in particular, shows that any unknown generates fear, and methods of care based on doubt and fear of complications may prove self-defeating [4–7].

A perfect example of this is the dogma, in stiff shoulder rehabilitation, of respecting the pain threshold, founded on the principle of “Above all, do no harm!” [8], out of fear of complications believed to correlate with pain [9–19]. This is all the more important as the onset mechanisms, etiology and nosology of complications (capsulitis, stiff shoulder, complex regional pain syndrome, frozen shoulder, etc.) are poorly known and their management remains empirical and beset by lack of knowledge [20–26].

The present study, therefore, examined the impact on experienced pain and on clinical outcome of different treatment options in stiff shoulder according to whether they respect the pain threshold or not.

Patients and method

A prospective multicenter study was performed on a series of 193 cases of stiff shoulder, comparing subjective and objective clinical evolution per treatment option according to whether the pain threshold is respected or not.

All patients presented with significantly reduced range of passive motion (passive forward flexion < 150°, external rotation more than 20° less than in the contralateral shoulder and reduced internal rotation). History of surgery for stiff shoulder, degenerative bone lesions and fractures less than 3 months old or non-consolidated were exclusion criteria.

Clinical and pain assessment included normalized shoulder examination in dorsal decubitus [27–29] and was performed on the day of inclusion and at 6 weeks, 3 months, 6 months, 1 year and at last follow-up, with analysis of history and of onset and objective (goniometry of ranges of motion) and subjective (Constant score) assessment [30] (Appendix 1: follow-up form).

Each rehabilitation session was assessed by either a physician or a physiotherapist: feasibility, pain level and duration for each conventional rehabilitation exercise (Appendix 2: rehabilitation follow-up form). The patients also filled out a subjective questionnaire, daily for the first 6 weeks and then weekly up to the 3rd month, scoring daytime and nighttime pain, functional disturbance and morale (for pain: 0 [no pain] to 10 [maximal pain]; disturbance: 0 = no disturbance; morale: 0 = morale at its lowest). At the same times, patients undergoing self-rehabilitation filled out a questionnaire assessing each exercise on the same criteria.

Four treatment groups were distinguished.

Conventional sub-threshold rehabilitation (CSR: \(n = 58\))

Patients were managed by conventional rehabilitation, respecting a pain threshold defined by a visual analog scale (VAS) score < 6/10. They had three to five sessions a week with a physiotherapist, in some cases working under a rehabilitation physician. The usual methods and exercises of conventional rehabilitation were applied [9,27] (Appendix 2: rehabilitation follow-up form).

Suprathreshold self-rehabilitation (SSR: \(n = 59\))

Patients were managed by self-rehabilitation (\(n = 59\)) or supervised self-rehabilitation (SSSR, below: \(n = 31\)) and encouraged to go over their pain threshold (i.e., over six on the VAS). They were asked to be reasonable and to divide the daily exercise load into 5–10-minute sessions spread over the day [27,28,31]. The exercises were simple ones, based on everyday movements [31]. The patients were left to themselves between the follow-up consultations.

Supervised suprathreshold self-rehabilitation (SSSR: \(n = 31\))

For this group, self-rehabilitation was backed up by sessions with a physiotherapist trained to include the idea of exceeding the pain threshold in the communication with the patient and in the physiotherapy treatment [27].
**Endoscopic circumferential capsulotomy with mobilization under anesthesia and conventional sub-threshold rehabilitation (CAPS; n = 45)**

The capsulotomy technique was classical [32–34] and rehabilitation was as in the CSR group.

An on-line database was set up (Carl Biostatistic™) with on-site assessment form data entry.

A comparative descriptive study was performed per treatment group and per technique (analysis of variance, t and Chi² tests; significance threshold, \( P < 0.05 \)) followed by a study of correlations between treatments and between assessment parameters (simple regression or bivariate correlations; significance threshold, \( P < 0.05 \)). Pain levels were studied on factorial analysis.

**Results**

One hundred and ninety-three patients were followed up for a mean 13 months (range, 3–21 months) after a mean of 12 months’ evolution (range, 8–31 months). Mean age was 50 years (range, 18–71 years) and the mean interval to inclusion 15 months (range, 5–28 months). The sex ratio was 62% female. Fifty percent of cases were considered spontaneous stiffness, with a mean interval to inclusion of 12 months, versus 3 months for post-traumatic stiffness (31%) and 9 months for stiffness secondary to surgery (12%).

There were no significant differences in baseline pain intensity between treatment groups. Pain intensity correlated directly with degree of stiffness in elbow-to-body external rotation [29] and forward flexion (\( P < 0.05 \)).

**Comparative descriptive functional evolution**

Fig. 1 compares evolution of overall function (Constant score) between treatment groups. Functional recovery on Constant score systematically correlated with mean pain intensity (\( P < 0.05 \)) and degree of stiffness (\( P < 0.05 \)). On factorial analysis, the pain criterion accounted for 83% of the overall Constant score (out of 100 points), although only 15 of the 100 points directly assess pain. This demonstrates the intercorrelation between pain and the objective and subjective factors of the Constant score as a whole.

**Conventional sub-threshold rehabilitation**

The CSR group presented with moderate to severe baseline pain (graded 6/10); day- and night-time pain, then progressively diminished but rose again significantly (\( P > 0.05 \)) after the 12th week, which usually corresponded to the time when the physiotherapist began to reduce treatment. Day- and night-time pain showed parallel evolution (Fig. 2). Fig. 3 shows the relation between functional improvement and alleviation of pain, with persistent moderate pain limiting functional recovery (\( P < 0.05 \)) over periods beyond 6 months.

**Suprathreshold self-rehabilitation**

In the SSR group, the evolution of day- versus night-time pain differed, with a large rapid decrease in the latter: 43% of patients free of night-time pain after 7 days (\( P < 0.05 \)). Daytime pain diminished strongly during the first days (\( P < 0.05 \)) then stabilized, with a background of persistent pain directly correlating to exercise duration (Fig. 4). Pain alleviation can be seen to stagnate between weeks 6 and 12, corresponding to a reduction in exercises and a lower rate of functional improvement (\( P < 0.05 \)), after which shoulder function improved in parallel to alleviation of pain (\( P < 0.05 \)) (Fig. 5).

**Comparison between pain evolution according to respect of the pain threshold entre (CSR vs SSR)**

The SSR group showed less pain than the CSR group during the first days (\( P < 0.05 \)). Thereafter, the exercises performed by the patient may sustain a background of daytime pain equal to or greater than in the CSR group, but with greater functional improvement during the first 6 weeks (\( P < 0.05 \)). When the frequency of exercise dropped, around week 12 of self-rehabilitation, the background of daytime pain in the SSR group diminished and mean pain intensity fell below the level of the CSR group and remained so until last follow-up (\( P < 0.05 \)) (Fig. 6).

The SSSR group, supervised by a physiotherapist, showed a pattern of evolution similar to the SSR group’s for the first 6 weeks, but with greater alleviation of pain between weeks 6 and 12 (\( P < 0.05 \)), and becoming again equivalent to the SSR level thereafter.

**Influence of capsulotomy on pain**

The evolution of pain in the CAPS (capsulotomy) group was the same as in the CSR group for the first 8 weeks, then becoming significantly better (\( P < 0.05 \)), at the level of the SSR and SSSR groups (Fig. 7).

**Synthesis of correlations**

In the groups treated with respect of the pain threshold (CSR and CAPS), daytime pain levels correlated with night-time levels (\( P < 0.05 \)), disturbance (\( P < 0.05 \)) and impaired morale (\( P < 0.05 \)). They were proportional to rehabilitation session duration and showed a systematic negative impact, decreasing after week 6, depending on the exercises performed, on goniometric range of motion and subjective and objective Constant criteria (\( P < 0.05 \)), and thus on the clinical result.

In the groups treated by self-rehabilitation exceeding the pain threshold (SSR and SSSR), daytime pain levels correlated with exercise intensity and duration (\( P < 0.05 \)). Unlike in the CSR and CAPS groups, daytime pain intensity correlated significantly with improvement in night-time pain, disturbance and morale (\( P < 0.05 \)), with positive impact on goniometric range of motion and function on the Constant score (\( P < 0.05 \)) at whatever time of follow-up.

**Failure**

Failure criteria were defined as anterior elevation < 140°, external rotation more than 20° less than contralaterally and Constant score < 70 points. Failure rates were identical.
Figure 1  Functional evolution according to treatment group. Constant score/100, week of FU.

Figure 2  Evolution of daytime and night-time pain under conventional sub-threshold rehabilitation.

Figure 3  Evolution of function and pain under conventional sub-threshold rehabilitation. Function/100% in blue (100%: maximal function), pain/100% in red (100%: maximal pain).

Figure 4  Dissociation of day- and night-time pain under suprathreshold self-rehabilitation. (10: maximal pain).

Figure 5  Evolution of function and pain under suprathreshold self-rehabilitation. Function/100% in blue (100%: maximal function), pain/100% in red (100%: maximal pain).

Figure 6  Evolution of mean pain under conventional sub-threshold rehabilitation and suprathreshold self-rehabilitation. (Maximal pain: 10).
with sub- or suprathreshold rehabilitation at 1 year (CSR, 14%; SSR, 17%) and at end of follow-up (CSR, 0%; SSR, 7%). Overall functional score (Constant score < 70) was lower with sub-threshold rehabilitation at 1 year \((P < 0.05)\) (CSR, 26% failure; SSR, 5.9%) but showed no significant difference at end of follow-up. The failure rate under sub-threshold rehabilitation correlated at 1 year with the level of the patient’s personal work and with pain intensity at final follow-up \((P < 0.05)\). The capsulotomy group showed no failures for whatever criterion, time point or pain level \((P < 0.05)\).

**Discussion**

There have been few studies of pain management in shoulder pathology \([9,14,31,34]\) and follow-up durations in follow-up studies made it difficult to assess the specific clinical impact of treatment modalities \([10,35–39]\).

The multicenter design of the present study may have biased the collection of certain results (subjective Constant scores), but the simple follow-up criteria (pain, disturbance, morale) were easy for the patient to assess, making the follow-up data reliable, sensitive and statistically interpretable.

Conventional rehabilitation in which patient and therapist take care to respect the pain threshold proved more painful at the beginning of treatment than self-rehabilitation with encouragement to exceed the threshold. During the following 6 weeks, conventionally managed patients suffered a little less than self-rehabilitating patients, but that was due to the intensity of the exercises performed by the latter. The therapeutic power of personal work has been proved \([40–42]\) and exercise intensity and its role in recovering muscle force is known to reduce pain and risk of dysfunction due to subacromial impingement \([14,43–45]\).

The resurgence of pain when conventional rehabilitation tails off or ceases after a few months is a well-known fact \([24,46,47]\), which we see as symptomatic of therapist dependence and lack of therapeutic education to sustain the results achieved with the physiotherapist. The culture of fear of pain and of the nebula of possible complications, usually unclearly understood by both patient and therapist \([9,13,14,48]\), seem to contribute to this end-of-treatment resurgence of pain.

Suprathreshold self-rehabilitation provides rapid relief, especially of night-time resurgence of pain. Residual pain is mainly daytime and directly correlated with the duration of the exercises performed by the patient, who is usually well motivated, reassured and exercising in a panic-free context \([1–49]\). The instructions at the very least restore a more peaceful daily life with control over stiffness-inducing anti-pain reflexes and particularly over reflex trapezoid contractures that induce or prolong shoulder stiffness \([9,28,31]\).

The self-rehabilitation exercise form is a material support, which may be considered symbolic in terms of medical technicality but the main role of which is to give the patient license to treat him or herself \([1,31]\). The present study shows that patients who work on and manage their exercises without fear of pain or complications achieve an immediately improved quality of life in terms of pain and morale, in direct proportion to their degree of personal commitment, with functional results that are both rapid and sustainable, not being dependent on therapists. The paradox is thus to accept and get the patient to accept a “liberating” pain that is efficacious only when associated to clear therapeutic education.

Supervision of suprathreshold self-rehabilitation by a trained physiotherapist, able to communicate soberly about complications and willing to involve the patient in pain-inducing but supervised personal exercises to which treatment will be adapted, avoids the discouraging effect of being too alone in managing one’s treatment \([40,47,48]\).

Capsulotomy provides no extra benefit in terms of pain compared to self-rehabilitation \([50]\), but ensures pain relief and non-recurrence as of the 3rd month of treatment. The heavy successive treatments entailed by capsulotomy severely medicalize care, but with long-term benefit that may make it indicated, in certain cases resistant, to other treatments.

Failure analysis directly implicated patient commitment: failure was associated with insufficient or defective personal exercise, showing the major role of active involvement and thus of therapeutic education in pain relief and clinical outcome. Less active patients suffer greater pain and should, therefore, be considered partially responsible for their own failure. Reassuring management of the pain threshold avoids complications such as complex regional pain syndrome, and the failure rate is similar to that in conventional rehabilitation.

**Conclusion**

Shoulder stiffness is a pathology that needs to be followed up for more than 1 year and in which experienced pain is a significant prognostic factor. The present study showed that patients undergoing sub-threshold rehabilitation suffer greater pain, with poorer results and lower morale than those performing self-rehabilitation.

We, therefore, consider that the tolerance threshold for pain inflicted on a passive and frightened patient is low, and impairs clinical evolution. In contrast, the tolerance threshold for an active and reassured patient is higher, which
enhances efficacy in performing exercises and improves clinical evolution in as much as the patient is managing a pain that has been explained and rendered less frightening.

The dogma of respecting the threshold for pain inflicted on the patient should give way to the idea of a "reasonable" pain threshold managed by a patient who is aware and involved. We need to move on from "respecting the pain threshold" to "managing the pain threshold", holding to the essential principles of therapeutic education and active patient involvement, without which therapeutic and analgesic success is not possible.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Appendix 1. Follow-up form
## Mode de début

- **Spontané** (arthropathies exclues)  
  - Si oui
  - Modèle (1=progressif, 2=brutal, 3=post-surnage)  
  - Délai (mois)
- **Post-traumatique**  
  - Si oui
  - Date trauma (j/m/a)
  - Type trauma (1=contusion, 2=fracture, 3=location)
  - Intervalle libre? (mois)
- **Post-chirurgical** (prothèses, ostéosynthèses exclues)  
  - Si oui
  - Date chirurgie (j/m/a)
  - Type chirurgie
    - 1=coiffe open, 2=coiffe AS, 3=stab open, 4=stab AS, 5=autre
  - Intervalle libre? (mois)

## Pathologie épaule associée (documentée)

- **Pb coiffe** (0=non, 1=calcif, 2=non calcif, 3=rupture)
- Autre (en clair) (0=non, 1=oui)

## Circonstances favorisantes

- **Endocrinienne**  
  - Si oui (1=diaète, 2=pt hypothyroïde, 3=autre)
- **Rhumatologique**  
  - Si oui (1=PR, 2=PPR, 3=autre)
- **Neurologique**  
  - Si oui (1=Parkinson, 2=ésotropie, 3=autre)
- **Chirurgicale**  
  - Si oui (1=coiffe, 2=abdomen, 3=autre)
- **Médicamenteuse**  
  - Si oui (1=anticoagul, 2=Isoniazide, 3=autre)
- **ATCD algodystrophie autre site**  
  - Localisation en clair
- Autre (0=non, 1=oui)

## Signes associés

- **Dupuytren main** (0=non, 1=oui)
- **Problème cervical** (0=non, 1=cervicalgias, 2=NCE)
- **Syndrome épaule-main** (0=non, 1=modéré, 2=sévère)
## Appendix 2. Rehabilitation follow-up form

![Rehabilitation follow-up form](image)

### References


