



Thermal Radiofrequency Ablation of the Shoulder: a Novel Technique “Palisade”

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Abstract

The aim of this study is to define the feasibility of radiofrequency ablation of the articular nerves of the shoulder joint using the novel “palisade” technique. Ten patients were included, with mean age of 72 ± 7 years. The first stage in the prone position was the installation of cannulas using palisade method for radiofrequency ablation of the lower branch of the suprascapular nerve, then also for the superior and acromial branches of the suprascapular nerve, and then of the axillary nerve in bipolar mode. After the first stage, the patient was turned over into the supine position. In the supine position, RFA of the superior nerve to subscapularis and glenohumeral branch of the lateral pectoral nerve and of the sensory branch of the lateral thoracic nerve was performed. The mean pain intensity decreased from 7.1 ± 1.4 to 1.8 ± 1.4 on NRS scale with significant increase range of motion from 70 ± 32 to 128 ± 54 during the first month after treatment. Positive changes after treatment continued up to 6 months after it. None of the patients had any adverse effects. The technique of radiofrequency denervation of the shoulder joint “palisade” is safe and effective. It can be used in patients with pain and limited range of motion in the shoulder; the duration of the effect can be from 6 months or more.

Keywords Shoulder pain · Radiofrequency ablation · Shoulder denervation · Interventional pain management

Introduction

Shoulder pain is a common problem, affecting up to 25% of the population with age [1]. Excluding manifestations of systemic diseases and referred pain, the most common causes of pain in the shoulder are articular pathology, osteoarthritis of the glenohumeral or acromioclavicular joint and Milwaukee shoulder; bone pathology, aseptic necrosis and others; soft tissue diseases, damage to tendons and ligaments; and rotator cuff tendinopathy, adhesive capsulitis, and others [2].

Management of treatment in these patients necessarily includes a complex of physical rehabilitation, therapeutic exercises and mobilization, low-level laser therapy, corticosteroids, acupuncture, electro-therapy, continuous passive motion, and deep heat [3].

Interventional treatment is represented by injections into soft tissues, bursa, and near tendons, which are performed mainly with ultrasound guidance [4].

There is also a lot of experience in radiofrequency denervation of the articular nerves of the shoulder joint; the vast majority of procedures are performed using the pulsed radiofrequency (PRF) technique. With improved understanding of nerve anatomy, the evolution of articular branch nerve ablation of the shoulder joint has progressed from the classic two-point (scapular notch and humerus neck) method of shoulder denervation to at least four-point ablation. However, despite extensive experience, the effectiveness of these procedures remains unclear, including due to the large scatter of procedure techniques, different methods of navigation, sensory and motor stimulation, modes of procedure, and a large scatter of potential anatomical targets for ablation [5]. The palisade technique is a variant of bipolar RFA where the cannulas are placed at a fixed distance from each other through a special device; this provides a predictable continuous line of nerve lesion within a defined outline [6]. In the case of ablation of the articular branches of the nerves of the shoulder joint, this technique can achieve a total lesion,

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regardless of the anatomical variability and branching of the nerves in each patient.

Aim

The aim of this study is to define the feasibility of radiofrequency ablation of the articular nerves of the shoulder joint using the “palisade” technique.

Study Design This is a retrospective observational study.

Materials and Methods

Patients

Ten patients were included, with mean age of 72 ± 7 years. The inclusion criteria were severe shoulder pain (at least 6 numeric rating scale (NRS) points), substantial limitation of movement in the affected shoulder, severe social dysfunction due to pain, and limitation of movement in the shoulder for at least 3 consecutive months prior to inclusion in the secondary to degenerative changes study shoulder. The diagnosis was confirmed by clinical examination and magnetic resonance imaging (MRI) of the affected shoulder joint to rule out secondary damage to the bones of the shoulder (mts, inflammatory arthropathy, etc.)

All patients had previously received pain management (NSAIDs, intra-articular or periarticular steroids, hyaluronic acid solutions, and, in one case, anticonvulsants). The last injections were performed at least 2 months prior to enrollment in the study. Informed consents were obtained from each patient (Table 1).

Procedure

The procedure for radiofrequency denervation of the shoulder joint was performed in the operating room. All patients received venous access, monitoring of ECG, blood pressure, HR, and SpO₂. All procedures were performed under local anesthesia Lidocaini 1%. Fluoroscopy (Cios Fusion, Siemens) was used for navigation.

After determining the main X-ray landmarks, the guide device was fixed along the proposed ablation line. An RFA cannulas (21G 10 mm active tip) was placed through the palisade guide device, and sensory and motor stimulation was attempted using an RF generator (RFG4, Cosman Medical, Burlington, Massachusetts).

Dysesthesia and a tingling sensation at the shoulder area appeared in all patients stimulated with voltage less than 0.3. Motor stimulation was negative at current values greater than 2.5 V. The radiofrequency (RF) treatment was administered in bipolar mode at 80° C for 90 s.

The first stage in the prone position was the installation of cannulas for radiofrequency ablation of the lower branch of the suprascapular nerve and then also from the upper access, 3 cannulas using the palisade method for the superior and acromial branches of the suprascapular nerve, and the next stage, 2 cannulas of the humeral neck, RFA of the axillary nerve in bipolar mode. After the first stage, the patient was turned over into the supine position. In the supine position, RFA of the superior nerve was performed, and, then, by placing the cannula on the coracoid, RFA of the sensory branch of the lateral thoracic nerve was performed. The step-by-step diagram is presented in Table 2.

Outcome Measures

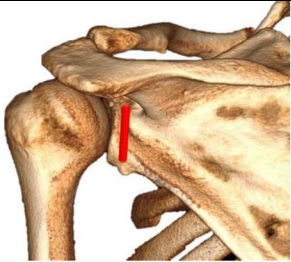
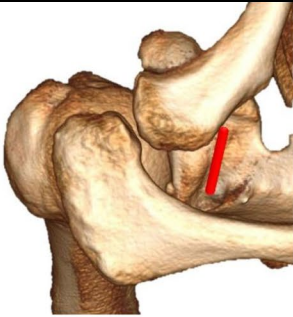
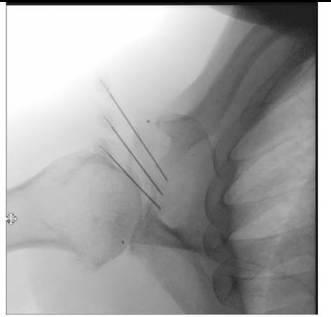
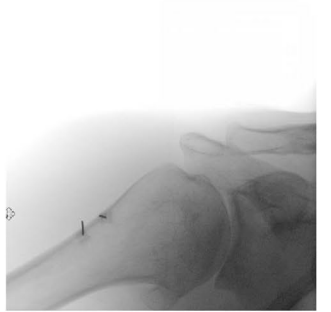
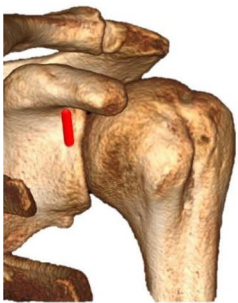
The observation period after the procedure was 1–9 months.

Table 1 Patient demographic and clinical characteristics

No	Gender	Age, y	Diagnosis	Previous treatment	Pain intensity, NRS	ROM
1	M	66	OA, impingement	ST	6	70
2	F	70	OA	NSAID, ST	7	45
3	M	80	OA	NSAID, ST	9	90
4	M	61	OA	NSAID, ST	5	80
5	M	81	OA+PHN	NSAID, AED, ST	6	20
6	F	73	OA	NSAID	6	70
7	M	80	OA	NSAID, ST	9	90
8	F	75	OA	NSAID, ST, HA	7	120
9	F	72	OA	NSAID, ST, HA	9	20
10	M	61	OA	NSAID, ST	7	90

NRS numeric rating scale, *ROM* range of motion, *OA* osteoarthritis, *PHN* postherpetic neuralgia, *NSAID* nonsteroidal anti-inflammatory drug, *ST* glucocorticosteroid injection, *HA* hyaluronic acid injection, *AED* antiepileptic drugs

Table 2 Stages of the palisade technique

No	Stage	Patient's position	Target	Scheme	X-ray picture
1	Infraspinous	Prone position	Inferior branch SSN		
2	Supraspinous		Superior branch SSN Acromial branch SSN		
3	Humeral		Axillary nerve		
4	Anterior		Superior nerve to subscapularis Glenohumeral branch LPN		
5	Coracoid	Supine	Acromial branch LPN Glenohumeral branch LPN		

SSN suprascapular nerve, LPN lateral pectoral nerve

Every patient reported the outcome monthly (outpatient clinic or phone calls). Pretreatment range of motion (ROM) and pain intensity was measured with a 0–10 NRS and compared to post-treatment values.

Statistical analysis was performed using StatPlus for Mac. Continuous variables are presented as mean $\pm$ standard deviation (SD). Within the group, differences were verified using the Wilcoxon rank sum test. The level of statistical significance was $P < 0.05$.

Results

All patients who underwent the procedure experienced significant pain relief and increased range of motion. The mean pain intensity decreased from 7.1 ± 1.4 to 1.8 ± 1.4 on NRS scale with significant increase range of motion from 70 ± 32 to 128 ± 54 during the first month after treatment. Positive changes after treatment continued up to 6 months after it. None of the patients had any adverse effects, including such as pain at the site of the procedure, vascular damage, infection, or weakness in the muscles of the shoulder and arm (Fig. 1).

Discussion

Pulsed radiofrequency ablation of the suprascapular nerve was the standard procedure for shoulder pain relief [7]. The basis for this was the idea that 70% of the innervation of the shoulder joint is provided by the suprascapular nerve, mainly the posterior, upper, and lower parts, and 30% is predominantly innervated by the n. axillaris in front [8]. Initially, ablation of the suprascapular nerve was performed predominantly in a pulsed mode rather than thermal mode in order to avoid damage to motor fibers and a lack of strength in the deltoid muscle [4]. The modest results of these procedures have prompted more aggressive modes of treatment

of the nerve — more frequent thermal ablations have been performed for more reliable nerve ablation with the transfer of the function of shoulder abduction to the supraspinatus muscle with a possible deficit in deltoid muscle strength, but the results of thermal ablation of this nerve turned out to be similar to those when performing pulsed ablation [5].

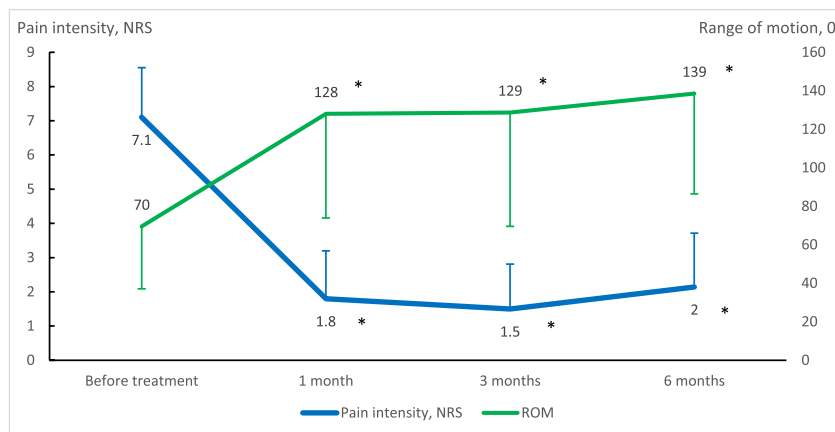
Cadaveric studies of the innervation of the shoulder joint have clarified the involvement of the sensory and motor portions in different parts of the nerves, as well as the importance of the lateral pectoral nerve in the innervation of the capsule, and the possibility of image-guided intervention on these nerves [9–11].

Modern ideas about the sensory innervation of the shoulder joint suggest the participation of 4 nerves: the superior and inferior branches of the suprascapular nerve, the acromial and glenohumeral branches of the lateral thoracic nerve, the superior nerve to subscapularis, and the axillary nerve [12]. In this regard, the number of target zones for destructive impact increases. The second problem is the anatomical variability in the location of the target nerve branches [8]. This requires repeated positioning of the cannula tip at different points for accurate navigation, even when using techniques with large coverage areas such as cryoablation or RF-cooled ablation, which can increase the cost of the procedure, the complexity of working with a single electrode, and large electrode diameter, which requires good local anesthesia [13].

A similar problem faced the denervation of the sacroiliac joint (SIJ) many small branches of nerves with an unpredictable location — in parallel with the improvement of knowledge about the anatomy of the innervation of the SIJ, the evolution of the RFA technique has gone from laborious perforaminal point ablation to a standardized palisade technique, where the skill of the performer is minimally involved, and the results are good and predictable [14].

The limitations of this study are the small sample size of heterogeneous patients, short observation period, and the absence of a comparison group.

Fig. 1 Pain intensity and range of motion (mean $\pm$ SD, $*p \leq 0.05$)



Conclusion

The technique of radiofrequency denervation of the shoulder joint “palisade” is safe and effective. It can be used in patients with pain and limited range of motion in the shoulder; the duration of the effect can be from 6 months or more.

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Author Contribution AV created the conception and design of the work, performed procedures, interpreted the data, and substantively revised it; SP performed procedures, collected data; and DK created the concept and idea of the anatomical basis. All authors read and approved the final manuscript.

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Data Availability Data will be available on reasonable request.

Code Availability Not applicable.

Declarations

Ethics Approval This retrospective study protocol was approved by the local ethics committee of the Pain Institute Moscow, Russia, in accordance with the Declaration of Helsinki.

Consent to Participate Informed written consent was provided from the patients for participation in this study.

Consent for Publication Informed written consent was provided from the patients for publication of these accompanying images.

Competing Interests The authors declare no competing interests.

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