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Original Research Article

Pulsed Radiofrequency in Frozen Shoulder, How Effective and Safe It Is?

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Abstract

Background: Frozen shoulder has been treated by conventional (continuous) radiofrequency but with fear of post procedure nerve damage.

Aims & Objective: In the present study, we investigated the outcome and safety of pulsed radiofrequency of suprascapular nerve as a treatment for frozen shoulder after failure or non-satisfactory result of conservative treatment.

Material & Methods: The study included 28 patients of frozen shoulder, who had undergone one-month conservative treatment. Mean age was 54 years which included 17 females and 11 males. There range of motion at shoulder joint and Oxford Shoulder Score (OSS) were abduction 117.14 $\pm 7.12^0$, flexion 111.78$\pm$7.72^0, internal rotation 83.5$\pm$6.79^0, external rotation 83.5$\pm$4.26^0 and OSS 30$\pm$3.26. These patients received Pulsed Radiofrequency of supra-scapular nerve under fluoroscopic guidance's. Patients were followed for six months.

Results: There was significant improvement in range of motion at shoulder joint and OSS, abduction 121.42$\pm$7.55^0 p value 0.0005, flexion 115.71$\pm$7.90^0 p value 0.0011, internal rotation 85.35$\pm$6.92^0 p value 0.01174, external rotation 86.21$\pm$4.56^0 p value 0.00749 and OSS 38.5$\pm$3.33. p value 0.0001, with no post procedure complications.

Conclusion: Pulsed radiofrequency offers effective and safe treatment for frozen shoulder.

Keywords: Frozen Shoulder, Pulsed Radiofrequency, Suprascapular Nerve, Continuous Radiofrequency.

Introduction

Since the introduction of conventional continuous radiofrequency lesion generator by Cosman in 1950, it has been used to treat chronic pain syndromes since 1974[1]. Because of neuronal damage produced by Conventional Radiofrequency there was a search for non-destructive treatment for pain. Radionics came up with prototype Pulsed RF generator. Sluijter started working on this prototype since 1996 and published first

report on PRF, clinical effect of Pulsed Radiofrequency on dorsal root ganglion in 1998[2]. Since then Pulsed RF has been used in axial backpain, lumbar radicular pain, cervical radicular pain, facial pain, inguinal pain, orchialgia, neuropathic pain. Pulsed Radiofrequency utilises radiofrequency current in short (20 ms), high-voltage bursts; the "silent" phase (480 ms) of PRF allows time for heat elimination, normally keeping the targeted tissue temperature below 42° C.

How PRF works is still debatable, histopathologic work in rat dorsal root ganglia and sciatic nerves using Pulsed RF electrodes at 42° C, has shown that PRF causes only transient endoneurial edema; in contrast with the Wallerian degeneration caused by CRF at 80°C [3]. Pulsed radiofrequency generates electrical fields that can affect neuronal membranes which is documented by several neurophysiologic researches that show PRF changes including synaptic signalling and causes electroporation[4]. Van Zundert *et al*[5] proved that PRF at 42° C for 120 seconds, PRF at 42° C for 8 minutes or CRF at 67° C performed on rat dorsal root ganglia that enhanced c-Fos expression in dorsal horn, a response which remained until 7 days after treatment. These results show a mechanism of c-Fos activation which is temperature independent and also indicate at the inhibition of excitatory C fibres and long-term depression as a viable therapeutic mechanism in PRF. Higuchi *et al*. [6], found increased c-Fos immune-reactivity in laminae I and II of the rat dorsal horn only in rats treated with PRF at 38° C and not in those treated with CRF at 38° C or sham. Richebe *et al*. [7] was not agree with the theory of a c-Fos–mediated pathway due to the lack of consistent molecular evidence and paucity of the controlled studies demonstrating the efficacy of Pulsed Radiofrequency overall. It is noteworthy that changes in c-Fos are associated with several cellular processes and that the upregulation of c-Fos noticed with PRF may be unrelated to the mechanism by which PRF produces its therapeutic effect. Activating transcription factor 3 (ATF3), an indicator of "cellular stress," is also increased with PRF; this effect is seen only in small-diameter C and Ad fibres [8]. Nevertheless, the real role of ATF3 is not clear as is the case with c-Fos. PRF may augment noradrenergic and serotonergic descending inhibitory systems within the spinal cord, which afforded an analgesic effect in an inflammatory pain model [9-17]. Initially it was thought that Pulsed RF is non-destructive procedure but Kyosuke *et al*[18] showed prolonging duration of pulsed radiofrequency treatment is associated with increased neuronal damage without further antiallodynic effects in neuropathic pain model rats. *ATF3* mRNA, a key marker of neurological damage,[19] significantly increased following treatment with PRF for 12 minutes compared to no PRF treatment. Aim of this study is to determine the efficacy and safety of Pulsed Radiofrequency in the management of Frozen Shoulder.

Material and Methods

This was a prospective observational study conducted in LLR Hospital, Kanpur after obtaining approval from institutional ethical committee. 30 patients were selected for Pulsed RF after failure of conservative treatment, 2 patients did not turn up in follow up after first follow up, results of 28 patients were analysed statistically. All Patients selected according to following criteria: Age between 18 years to 60 years both male and female. Patients undergoing shoulder pain with fulfilling criteria of frozen shoulder i.e. Subjects with pain and limitation of movement around shoulder joint and normal x-ray of shoulder joint were included in this study.

Traumatic and infective causes of pain and limitation of movement, local infection

preventing needle placement, bleeding diathesis, allergy to local anaesthetic agents and patient refusal were excluded in this study. Investigation were done Complete hemogram, Blood coagulation profile, Renal functional test, Liver functional test, ECG, Serum electrolyte, blood sugar (FF/PP), X-ray shoulder AP and Oblique/outlet view.

Patient placed in prone position, with help of C-ARM fluoroscopy RF canula with 10mm active tip was placed in suprascapular notch on affected site, sensory and motor stimulations done for confirmation of placement and pulsed RF 40^0 for total 8 minutes, 4 minutes in one direction and second set after rotating needle to 180^0 given. No steroid or local anaesthetic agent was given.

Patients were followed for 6 months after Pulsed RF in terms of:

1. Range of motion (by goniometer):

Abduction:120^0or $<120^0$

Flexion:130^0or $<130^o$

Internal rotation:90^0 or $<90^0$

External rotation:80^0or$<80^0$

In symptomatic subjects, the reliability of tests for shoulder joint range of motion has yet to be determined. For this reason, inter-rater and intra-rater agreement trials were undertaken to ascertain the reliability of visual estimation, goniometry, still photography, "stand and reach" and hand behind back reach for six different shoulder movements. Intra-class correlation coefficients (Rho) were derived by using a random effects model. For flexion, abduction and external rotation fair to good reliability was demonstrated for both trials using visual estimation (inter-rater Rho = 0.57-0.70; intra-rater Rho = 0.59-0.67), goniometry (inter-rater Rho = 0.64-0.69; intra-rater Rho = 0.53–0.65) and still photography (inter-rater Rho = 0.62-0.73; intrarater Rho = 0.56–0.61). The tests had standard errors of measurement of between 14 and 25 degrees (inter-rater trial) and 11 and 23 degrees (intra-rater trial).

2. Oxford shoulder score

We took patients having OSS score 20-35 which falls in category moderate to severe shoulder arthritis according to OSS severity classification

Interpreting the Oxford Shoulder Score [20-22]

Interpreting the Oxford Shoulder Score	
Score 0 to 19	May indicate severe shoulder arthritis. It is highly likely that you may well require some form of surgical intervention, contact your family physician for a consult with an Orthopaedic Surgeon.
Score 20 to 29	May indicate moderate to severe shoulder arthritis. See your family physician for an assessment and x-ray. Consider a consult with an Orthopaedic Surgeon.
Score 30 to 39	May indicate mild to moderate shoulder arthritis. Consider seeing you family physician for an assessment and possible x-ray. You may benefit from non-surgical treatment, such as exercise, weight loss, and /or anti-inflammatory medication
Score 40 to 48	May indicate satisfactory joint function. May not require any formal treatment.

We analysed both Parameters at confirmation of diagnosis(Visit Dx), at one month after conservative treatment(Visit CTt), first visit after 7 days of radiofrequency intervention(Visit-1), 2nd visit after first month of intervention(Visit-2), 3rd visit after 3rd month of intervention(Visit-3) and 4th last visit after 6th month of intervention(Visit-4).

Result

All the patients attended all the follow up appointments. The baseline demographic data are given in Table-1. Initial range of motion and OSS were recorded before procedure (this was termed Visit Dx Table-2). After procedure (Pulsed Rf) patients were assessed in terms of range of motion and OSS. Pre and post procedure ROM & OSS were compared there was significant improvement in range of motion (Abduction, Flexion, Extension) & OSS, p value less than 0.05. (Table-3).

Table 1: Demographic data (Visit Dx)

S. No.	Parameters	(n=28) Mean ± SD
1.	Age	54.78±10.53
2.	Gender	Female- 17 Male-11
3.	Height	162.14±10.54
4.	Weight	55.64±10.38

Table 2: Range of motion at shoulder joint & oxford shoulder scoring at the time of diagnosis (Visit Dx)

1.	Abduction	107.14 ± 8.96^0
2.	Flexion	103.9 ± 7.37^0
3.	Internal rotation	75.42 ± 4.80^0
4.	External rotation	74.21 ± 4.26^0
5.	OSS	20.85±6.21

Table 3: Range of motion at shoulder joint & oxford shoulder scoring after one month of conservative treatment (Visit CTt)

S.No.	Parameters	After Conservative Treatment (Mean ± SD)
1.	Abduction	117.14 ± 7.12^0
2.	Flexion	111.78 ± 7.72^0
3.	Internal rotation	83.5 ± 6.79^0
4.	External rotation	83.5 ± 4.26^0
5.	OSS	30±3.26

Patient were followed till 6-month post procedure (Table-4). At 4th visit of patients' there was no significant improvement in range of motion and OSS was noted. As compared to pre-procedure values p value was more than 0.05 except for external rotation (Table-5).

Though there was significant improvement till 3rd visit i.e., 3 months after procedure was done (Table-6). There was no complications found post-procedure. (Table-7).

Table 4: Range of motion at shoulder joint & oxford shoulder scoring after pulsed radiofrequency

Parameters	**(n=28)**
Abduction	
Visit 1	121.42±7.55^0
Visit 2	121.42±7.55^0
Visit 3	121.22±7.55^0
Visit 4	121.00±7.55^0
Flexion	
Visit 1	115.71±7.90^0
Visit2	115.71±7.90^0
Visit 3	115.01±7.90^0
Visit 4	114.71±7.90^0
Internal rotation	
Visit 1	85.35±6.92^0
Visit 2	85.25±6.92^0
Visit 3	85.00±6.92^0
Visit 4	85.00±6.92^0
External rotation	
Visit 1	86.21±4.56^0
Visit 2	86.72±4.72^0
Visit 3	86.20±4.72^0
Visit 4	86.07±4.59^0
OSS	
Visit 1	38.5±3.33
Visit 2	39.21±3.45
Visit 3	39.2±3.72
Visit 4	39.0±3.33

Table 5: Range of motion at shoulder joint & oxford shoulder scoring after one month of conservative treatment & after pulsed radiofrequency (n=28):

S.No.	**Parameters**	**After Conservative Treatment (Mean ± SD)**	**After Pulsed RFA (Mean ± SD)**	**p value**
1	**Abduction**	117.14 ±7.12^0	121.42±7.50^0	0.0005
2	**Flexion**	111.78±7.72^0	115.71±7.90^0	0.0011
3	**Internal rotation**	83.5±6.79^0	85.35±6.92^0	0.01174
4	**External rotation**	83.5±4.26^0	86.21±4.56^0	0.00749
5	**OSS**	30±3.26	37.5±3.0	0.0001

Table 6: Range of motion at shoulder joint & oxford shoulder scoring at time diagnosis, after conservative treatment and 6 months follow up after pulsed radiofrequency

	Abduction	Flexion	Internal rotation	External rotation	OSS
Visit Dx	107.14±8.96^0	103.9±7.37^0	75.42±4.80^0	74.21±4.26^0	20.85±6.21
Visit CTt	117.14 ±7.12^0	111.78±7.72^0	83.5±6.79^0	83.5±4.26^0	30±3.26
Visit 1	121.42±7.55^0	115.71±7.90^0	85.35±6.92^0	86.21±4.56^0	38.5±3.33
Visit 2	121.42±7.55^0	115.01±7.90^0	85.25±6.92^0	86.72±4.72^0	39.21±3.45
Visit 3	121.22±7.55^0	115.01±7.90^0	85.00±6.92^0	86.20±4.72^0	39.2±3.72
Visit 4	121.00±7.55^0	114.71±7.90^0	85.00±6.92^0	86.07±4.59^0	39.0±3.33

Table 7: Complications after pulsed radiofrequency

	Infection	Sensory deficit	Motor deficit	Others
Visit 1	0	0	0	0
Visit 2	0	0	0	0
Visit 3	0	0	0	0
Visit 4	0	0	0	0

Discussion

Duplay[25] in 1872 described an entity of "periarthritis scapulohumeral" which was similar to frozen shoulder. Codman [26] first used the term frozen shoulder in 1934, described the common features of a slow onset of pain felt near the insertion of the deltoid muscle, restriction in both active and passive elevation and external rotation and inability to sleep on the affected side, even with normal radiographic findings. Incidence of frozen shoulder is 3%-5% in the general population and up to 20% in diabetics[27]. Frozen shoulder is relatively more common in females and peak incidence is in between 40-60 years and is less common outside these age groups and in manual workers[28].

Adhesive capsulitis and frozen shoulder both are used to describe a painful and stiff shoulder. According to American Shoulder and Elbow Surgeons[29], "Frozen shoulder is a condition of unknown aetiology characterized by significant restriction of both active and passive shoulder motion that occurs in the absence of known intrinsic shoulder disorder". Frozen shoulder is divided into two groups: primary and secondary by Lundberg[30].

Stage	Duration
Stage1 Freezing (Painful)	Up to 9 months
Stage 2 Frozen (Stiffening)	4 months-20 months
Stage 3 Thawing	5 months- 26 months
Contralateral shoulder	6 months-7 years after initial onset of symptoms

Contralateral frozen shoulder is seen in diabetes and young patients[27-29].

In adhesive capsulitis there are immune, inflammatory and fibrotic changes seen[31-33]. There is inflammation in the joint capsules leading to adhesion and fibrosis of the synovial lining. This is followed by contraction and thickening of shoulder joint capsule and formation of collagenous tissue around the joint this in-turn reduces joint capacity.

Differential diagnosis includes cervical radiculopathy, fracture, shoulder joint osteoarthritis, calcifying tendinitis, rotator cuff tendinitis/tendinopathy, subacromial impingement and bursitis.

The mainstay of treatment for the frozen shoulder are Physiotherapy, NSAIDs, surgical management under general anaesthesia and Recently Minimally invasive radio-frequency treatment has been added.

Continuous radio-frequency has been tried successfully in different painful conditions for long time but there was always fear of radiofrequency induced nerve palsy. Since the introduction pulsed radiofrequency, its neuro-modulatory effects have been tried in different painful conditions.

In present study we have analysed outcome of pulsed radiofrequency in frozen shoulder in terms of change in range of motion and Oxford shoulder score. At the time of diagnosis range of motion at shoulder joint was, abduction 107.14±8.960, flexion 103.9±7.370, internal rotation 75.42±4.800, external rotation 74.21±4.260 and OSS 20.85±6.21 After one month of conservative treatment patients who had not achieved satisfactory improvement, were posted for fluoroscopic guided pulsed RF, 42o temperature for 8 minutes.

With no steroid or local anaesthetic injection in suprascapular nerve. After one month of conservative treatment range of motion at shoulder joint was abduction117.14 ±7.120, flexion 111.78±7.720, internal rotation 83.5±6.790, external rotation 83.5±4.260 and OSS 30±3.26. Post Pulsed Radiofrequency follow up was done up to six months. First follow up assessment was done after one week of Pulsed RF abduction121.42±7.550 p value 0.0005, flexion 115.71±7.900 p value 0.0011, internal rotation 85.35±6.920 p value 0.01174, external rotation 86.21±4.560 p value 0.00749 and OSS 38.5±3.33. p value0.0001. There was significant improvement in range of motion at shoulder joint and OSS. This improvement in range of motion continued till six months of follow up. Also till six months of follow up we did not find any complication in form infection, sensory or motor deficit.

Conclusion

Frozen shoulder if not relieved by conservative treatment can be managed by radiofrequency treatment, now instead of ablative effect the neuro-modulatory effect of pulsed radiofrequency can be used safely without any risk of sensory or motor deficit. In our present study we found that pulsed radiofrequency has showed significant improvement in terms Oxford Shoulder Score and range of motion without use of steroid and local anaesthetic agent. This can be especially helpful in those patients having labile diabetes, hypertension. As in continuous radiofrequency often local anaesthetic with steroid is to be given to prevent post-operative neuropathic pain from ablation. Longer follow up studies are needed to ascertain pain relief from pulsed radiofrequency.

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