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Retrospective Comparison of the Efficacy of Pulsed Radiofrequency of the Suprascapular Nerve and Combined Transcutaneous Radiofrequency Techniques in Supraspinatus Tendinopathies

Supraspinatus Tendinopatisinde Supraskapular Radyofrekans ve Kombine Transkutanöz Radyofrekans Tekniklerinin Etkinliğinin Retrospektif Olarak Karşılaştırılması

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ABSTRACT

Objective: Pain in supraspinatus tendinopathy can often be reduced with conservative or minimally invasive treatment options, including pulsed radiofrequency of the suprascapular nerve (PRFSN) and transcutaneous pulsed radiofrequency (TPRF). However, there is no study in which these two methods are applied together. In the current study, the aim was to investigate possible changes in the analgesic effect when TPRF was added to PRFSN.

Methods: The study included 64 patients. In 36 of these patients, only 4 minutes of pulsed radiofrequency was applied to the suprascapular nerve, and this group was called Group S. In the remaining 28 patients, 4 minutes of pulsed radiofrequency plus 8 minutes of TPRF were applied to the suprascapular nerve, and this group was defined as Group S+T. The Numerical Rating Scale (NRS) scores of the two groups were compared before and after the procedure and at the 3rd and 6th month follow-up evaluations.

Results: There was no significant difference between the groups in terms of gender. However, a statistically significant difference was found in relation to the mean age, with the group receiving the combined treatment having a higher mean age (p=0.001). A significant difference was observed between the pre- and post-procedure NRS scores in both groups. However, while there was no significant difference between the two groups in terms of the initial and 3rd month NRS scores, a significant difference was detected at the 6th month follow-up (p=0.01), indicating an increase in pain in Group S. Although there was an increase in pain from the 3rd to 6th month NRS scores of Group S, this was not statistically significant. When the initial NRS scores were compared with the 6th month values, the mean NRS score decreased from 7.3 to 3.6 in Group S and from 7.2 to 2.6 in Group S+T.

Conclusion: The combined treatment was found to be more effective than PRFSN.

Keywords: Shoulder, chronic pain, radiofrequency, nerve block

ÖZ

Amaç: Supraspinatus tendinopatisinde ağrı çoğu zaman konservatif veya minimal invaziv tedavi seçenekleri ile azaltılabilir. Supraskapular sinire uygulanan radyofrekans ve transkutanöz radyofrekans bu yöntemlerdendir. Ancak bu iki yöntemin birlikte uygulandığı çalışma yoktur. Bu çalışmada SNRF'ye TPRF eklendiğinde analjezik etkide olabilecek değişikliğin araştırılması amaçlanmıştır.

Yöntem: Çalışmaya 64 hasta dosyası dahil edildi. Bunların 36'sına sadece supraskapular sinire 4 dk pulse RF uygulandı, bu grup Grup S olarak adlandırıldı. Hastaların 28'ine supraskapular sinire 4 dk pulse RF+8 dk transkutanöz RF uygulandı, bu grup da Grup S+T olarak tanımlandı. Her iki grubun hem işlem öncesi hem işlem sonrası 3. ay ile 6. ay kontrollerindeki Numerik Ağrı Skalası (NRS) skorları karşılaştırıldı.

Bulgular: Gruplar arasında cinsiyet açısından anlamlı farklılık saptanmadı. Gruplar arasında ortalama yaş açısından istatistiksel olarak anlamlı farklılık saptandı, kombine tedavi uygulanan grup daha yaşlıydı (p=0,001). Her iki grupta da işlem öncesi ve sonrası NRS değerleri arasında anlamlı fark saptandı. Ancak işlem öncesi ve işlemden 3 ay sonraki kontrollerde gruplar arasında NRS açısından anlamlı fark saptanmazken, 6. ay kontrollerinde fark saptandı (p=0,01), Grup S'de ağrıda artma tespit edildi. Grup S'nin 3. ve 6. ay NRS değerleri arasında ise ağrıda artış olmasına rağmen istatistiksel olarak fark saptanmadı. Başlangıç NRS skorları 6. ay değerleri ile karşılaştırıldığında, ortalama NRS skoru Grup S'de 7,3'ten 3,6'ya ve Grup S+T'de 7,2'den 2,6'ya geriledi.

Sonuç: Kombine tedavi tek başına transkütanöz radyofrekans yönteminden daha etkili bulundu.

Anahtar sözcükler: Omuz, kronik ağrı, radyofrekans, sinir bloğu

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INTRODUCTION

Rotator cuff disease is a term that encompasses tendinopathy, partial or total rupture of one or more rotator cuff tendons, and subacromial bursitis. The inflammation and compression of the supraspinatus tendon are the most common causes of rotator cuff disease (1). Approximately 10% of the adult population suffers from shoulder pain at some point in their lives (2). According to Van der Windt 23% of new-onset shoulder pain completely heals within one month and 44% within three months; however, symptoms become permanent in 41% of patients after one year, and therefore there is a need to try different treatment options (3). Pain can often be reduced with conservative or minimally invasive treatment options. Pulsed radiofrequency of the suprascapular nerve (PRFSN) and transcutaneous pulsed radiofrequency (TPRF) are among the methods applied in these patients. However, there is no study evaluating the combined use of these two methods. In this study, we aimed to investigate possible changes in the analgesic effect when TPRF was added to PRFSN.

MATERIAL and METHOD

After obtaining approval from the ethics committee for this retrospective observational study (date: 10/02/2022, decision number: 1766), the files of 92 patients were screened for the period from November, 2019 to June, 2021. Patients with supraspinatus tendinitis or rupture aged over 18 years, who complained of shoulder pain for at least three months without a history of malignancy in the shoulder region or ipsilateral motor deficit were included in the study. All the patients had previously received medical treatment and physiotherapy, which had reduced their pain level by less than 50%. Patients with any additional shoulder pathology other than supraspinatus tendinitis/rupture, those with a pain duration of less than three months, younger than 18 years of age, with malignancies or ipsilateral motor deficits in the shoulder region, that had not received medical treatment or physiotherapy before, and that did not undergo radiofrequency (RF) were excluded from the study. A total of 64 cases were included in the sample (Figure 1, flow diagram). All patients were first administered a steroid/local anesthetic injection into the subdeltoid bursa under ultrasonography guidance (Figure 2). Then, RF is applied to patients who have reduced shoulder abduction limitation and have a pain level reduced by at least 50%. In 36 of these cases, only 4 minutes of pulsed RF was applied to the suprascapular nerve, and this group was called Group S. The remaining 28 patients received 4 minutes of PRFSN + 8 minutes of TPRF, and this group was defined as Group S+T.

For two techniques we used same RF device (Top Lesion Generator TLG-10, Japan). Pulsed RF of the suprascapular nerve was applied as standard four-minute pulsed RF (2 Hz frequency, 45 volts, and 20 ms pulse interval) at 42 °C (Figure 3). We used the out of plane technique from the posterior of shoulder with the C1-5-D convex probe (GE Healthcare, Voluson™ E6, Turkey). Transcutaneous pulsed RF was applied to two separate regions for 4 minutes each, for a total of 8 minutes (2 Hz frequency, 80 volts, and 20 ms pulse interval) by each pad was 45x98 mm (44 cm²) in size (Figure 4A, B). In the first region, the pads were attached to the anterior and posterior of the glenohumeral joint. The posterior pad was placed over the scapula. In the second region, one pad was placed on the acromioclavicular joint, and the other pad was placed on the deltoid muscle in the humerus. The patients were called for a follow-up evaluation at 2 weeks, 1 month, 3 months, and 6 months after the procedure. Resting pain of 2 groups was evaluated with the Numerical Rating Scale

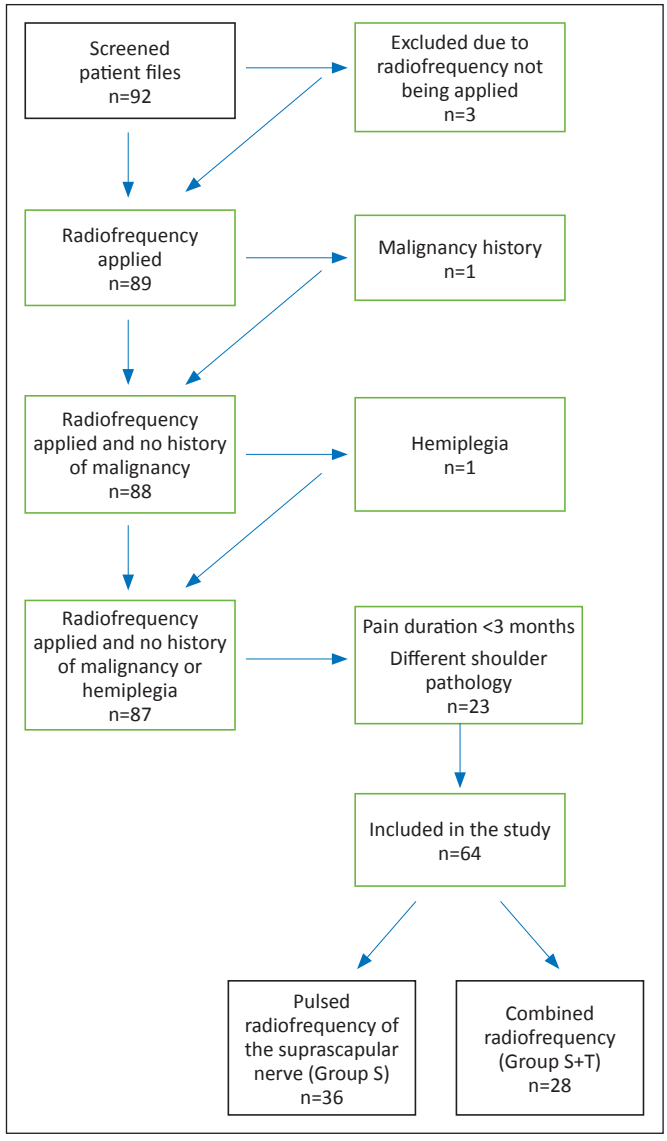

Figure 1. Flow diagram.

(NRS) (0-10) scores. The NRS scores of the two groups were compared before and after the procedure and between the 3rd and 6th month follow-up evaluations.

Sample size analysis was performed to evaluate the number of cases. The primary outcome variable of the study was the NRS score. The significance of the difference between the groups in the change in NRS score at the end of the 6th month compared to baseline was studied with Student's t. According to Student's t test, the current effect size (Cohen's d) of 0.799 and the current power of the study is 87.8% when analyzed at the 5% error level. Under current conditions, at least 26 cases must be assigned to each of the groups (when the allocation rate is accepted as 1:1) to have at least 80% power.

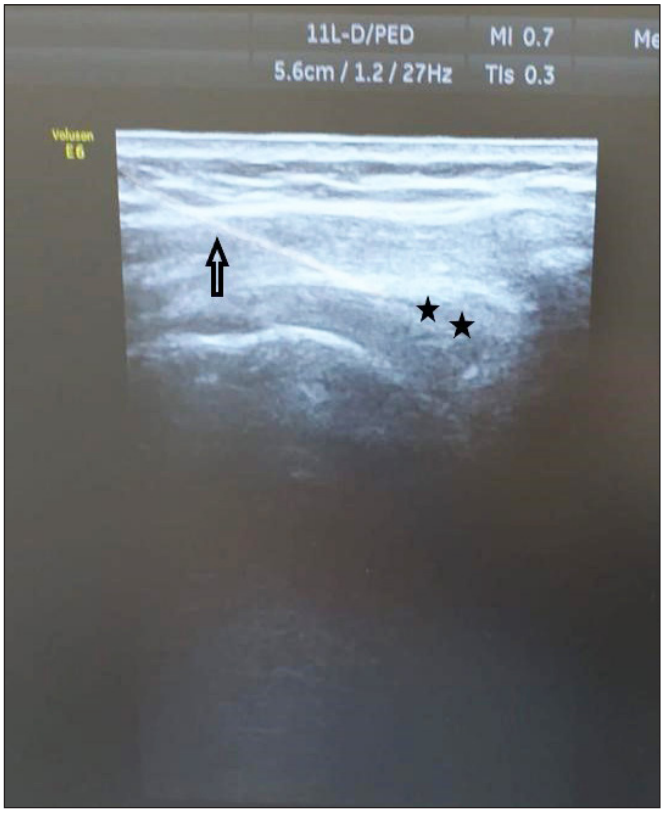

Figure 2. Ultrasonography-guided subdeltoid bursa injection. **Star:** Subdeltoid bursa, **Arrow:** Needle.

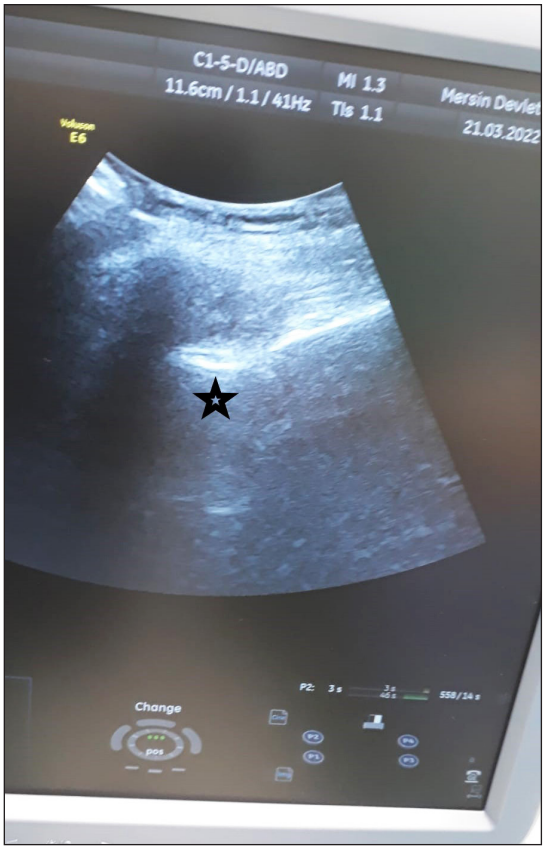

Figure 3. Suprascapular radiofrequency application using ultrasonography. **Star:** Suprascapular nerve.

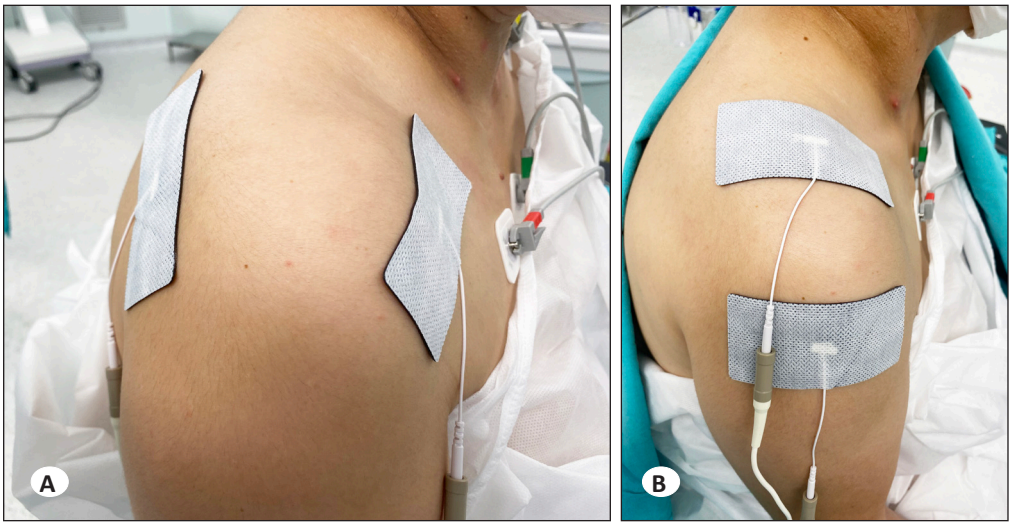

Figure 4. Transcutaneous radiofrequency application
A) The pads were attached to the anterior and posterior of the glenohumeral joint.
B) One pad was placed on the acromioclavicular joint, and the other pad was placed on the deltoid muscle in the humerus.

Table I. Age, NRS Scores and Pain Durations of the Study Groups

	Group S	Group S+T	p
Age mean ± SD (min-max)	52 ± 9.78 (32-71)	62.3 ± 10.86 (37-85)	p=0.001
Gender Male/Female	23/13	13/15	p=0.64
NRS score,			
initial	7.3 ± 1.15	7.2 ± 1.28	p=0.36
third-month follow-up	3.0 ± 1.95	2.7 ± 1.9	p=0.27
sixth-month follow-up	3.6 ± 1.17	2.6 ± 1.3	p=0.01
Pain duration (mean) (months)	8.6	8.1	

NRS: Numerical Rating Scale, **SD:** Standart deviation.

Statistical Analysis

For statistical analysis, SPSS v. 16 Windows package program (SPSS Inc. Chicago, II, USA) was used. Continuous variables and categorical data were compared using Student's t test and the chi-square test. P<0.05 was considered statistically significant. Shapiro-Wilk test was used to investigate whether the normal distribution assumption was met.

RESULTS

There was no significant difference between the groups in terms of gender. No complications were observed in the follow-up examinations of any of the patients. A statistically significant difference was found between the groups in terms of the mean age, with the group receiving combined treatment having a higher mean age (p=0.001) (Grup S=52, Grup S+T=62.3). In Group S tendinitis was detected in 19 patients and tendinitis+rupture was detected in 17 patients. Tendinitis was detected in 14 patients and tendinitis+rupture was detected in 14 patients in Group S+T. There was a significant difference between the pre- and post-procedure (p=0.36, p=0.27 respectively) NRS scores of both groups. For Group S and Group S+T initial mean NRS scores were 7.3 and 7.2 respectively, 3rd month mean NRS scores were 3.0 and 2.7 respectively. However, while there was no significant difference between the two groups in terms of the initial and 3rd month NRS scores, a significant difference was detected at the 6th month follow-up (p=0.01), indicating an increase in pain in Group S (Table I). Although there was an increase in pain from the 3rd to 6th month NRS scores of Group S, this was not statistically significant. When the initial NRS scores were compared with the 6th month values, the mean NRS score decreased from 7.3 to 3.6 in Group S (p<0.001) and from 7.2 to 2.6 in Group S+T (p<0.001).

DISCUSSION

Shoulder pain is one of the most common pathologies in algology clinics. If patients do not benefit from medical treatments and physiotherapy modalities, interventional treatments are usually the next step. Ultrasonography-guided bursa injections, suprascapular nerve blocks, PRFSN, and transcutaneous bipolar RF are among treatment options in these patients. Suprascapular RF and TPRF are among the most preferred methods recently, but there is no literature in which these two methods are applied together. Patients with persistent pain that does not go away, although they have received medical treatment and physiotherapy, usually apply to our clinic. Therefore, the application of these two methods together is one of the preferred treatment options in our clinic. When we compared our results, we saw that although there was no difference in terms of pain control in the short term, the combined treatment was more effective from the 6th month.

Pulsed RF of the suprascapular nerve is a technique that has been used for a long time with proven efficacy. As first described by Rohof, PRFSN is widely used for shoulder pain in clinical trials, demonstrating that this application can achieve desired results for relatively long-term pain relief and function restoration without the risk of paralyzing the supraspinatus and infraspinatus muscles (4).

In a study investigating the efficacy of PRFSN in hemiplegic patients, Alanbay et al. applied a suprascapular nerve block with lidocaine to 15 patients (Group NB) and 120-sec pulsed RF to other 15 patients (Group PRF) (5). In the controls 3 months later, the shoulder range of motion of the nerve block group did not change, while a significant improvement was observed in the PRF group. The decrease in the Visual Analog Scale (VAS) scores at the 1st and 3rd month follow-up was statistically higher in Group PRF than in Group NB. In another study, Gofeld et al. applied a suprascapular nerve block to patients with chronic shoulder pain under fluoroscopy guidance, followed by PRFSN for two minutes in Group R and RF with demo-box (placebo group) in Group L (6). Compared to the placebo group, a significant reduction in pain was detected at the 1st and 3rd month follow-up evaluations of the patients. There was no significant difference between the two groups at the 6th month follow-up. The authors empha-

sized that RF was a reproducible process, with its effect lasting for 4 to 5 months in each application. In our study, RF was performed without a suprascapular nerve block. Although there was a slight increase in pain in Group S at 6 months, this difference was not statistically significant, and the NRS scores were still low. This can be attributed to the long duration of RF efficacy. The lack of an increase in pain after 6 months in the group treated with combined treatment indicates that the combined application of the two RF techniques prolongs the duration of efficacy.

There are also publications reporting that PRFSN is not superior. Eyigor et al. compared intra-articular corticosteroid injection and pulsed RF techniques in painful shoulders (7). There were significant differences in the nocturnal VAS scores at the 1st, 4th, and 12th weeks, resting VAS scores at the 1st and 4th weeks, VAS scores during movement within one week, and The Shoulder Pain and Disability Index (SPADI) pain and total scores at the 1st, 4th, and 12th weeks, all in favor of the corticosteroid injection group. Liu et al. examined randomized controlled studies in a review (8). Five prospective studies with a follow-up of at least 12 weeks comparing PRF and control groups were included in the review. As a result, the use of PRF therapy in patients with shoulder pain was observed to provide good clinical efficacy for at least 12 weeks with no reported complications. However, current publications are still unclear in terms of whether PRF is superior to other treatment options, such as intra-articular corticosteroid injection and conventional TENS therapy. This has led to the search for new treatments for chronic shoulder pain. Transcutaneous pulsed RF is a technique that has started to be preferred in recent years. While PRFSN is a minimally invasive technique, the non-invasive nature of TPRF is among the reasons for its increasing popularity.

The first study on TPRF was published by Balogh in 2004 in a series of 4 cases; 2 with lower back pain, 1 with wrist pain, and 1 with neck and arm pain (9). In these cases, RF [60-80 V, 10 minutes, 20 ms, and 2 pulse per second (pps)] was applied to the skin of the painful area through TENS electrodes. Treatment was repeated for 1 year at intervals of 1 to 5 weeks. Three out of 4 patients reported significant pain relief after treatment, lasting up to 4 weeks.

Lin et al. applied TENS to 25 of 50 patients and TPRF to 25 of 50 patients with chronic shoulder pain (10). Both procedures were applied in 3 sessions undertaken every other day for 15 minutes each. Both were reported to be non-invasive and cause no discomfort for patients, but the TENS group felt paresthesia during the procedure, while the TPRF group did not feel anything during the procedure and were more comfortable. Although both procedures were found to be effective in reducing pain, more significant improvement was detected in the TPRF group. The authors attributed this to the inability of TENS to affect deep tissues as much as TPRF. Therefore, they concluded that TENS was not as successful as TPRF in reducing pain. One of the inclusion criteria of our study was for the patients to have received physiotherapy treatment. Transcutaneous electrical nerve stimulation was applied to all of these patients during physiotherapy, but adequate analgesia could not be achieved. The decrease in pain after RF supports the idea that RF is more effective than TENS.

In a study conducted by Taverner and Loughnan with 51 patients who were planned to undergo shoulder surgery at the orthopedic clinic, active TPRF was applied to 25 patients who had received interventional treatment before surgery, while inactive sham therapy was undertaken in 26 patients (11). Active treatment was applied to 6 standard areas as bipolar RF for 2 minutes at 80 volts and 10 ms, with 5 pulses/every second in a single session, for a total of 15 minutes. Nocturnal pain, resting pain, and pain during activity were evaluated with VAS. In addition, the Brief Pain Inventory aggregate pain (BPI-p) score and the Oxford Shoulder Score were used. There was a significant decrease in nocturnal pain, pain during activity, and BPI-p score in the group that received active treatment. No significant change was observed in the sham treatment group. At the end of the 12 weeks, seven patients in the active group and two patients in the sham group abandoned surgery. The authors emphasized that TPRF was effective in reducing shoulder pain at a level that would eliminate the need for surgery. Although TPRF was applied alone, it provided effective analgesia. This shows the importance of the duration of application and the number of regions treated. Taverner et al. conducted another study with patients who were scheduled for surgery for the knee (12). While 24 patients received active TPRF therapy, 24 received inactive sham therapy. The VAS scores significantly improved in the active group compared to the inactive group. This improvement was seen both at rest and during exercise. The effect of RF continued to increase at the 4th week compared to the 1st week, but the authors did not evaluate the time elapsed between the treatment time and the onset of pain reduction (latent period), which had been previously addressed by Balogh (9). The authors warranted additional studies to examine this latent period. Similarly, Taverner et al. applied TPRF to a total of 15 shoulders in 13 patients (13). Treatment was first started in 2006, and the results of cases treated up to 2009 were published. During this period, the treatment protocols were modified in order to achieve more effective results. The treatment was initially applied with 2 positions for 2 minutes (four minutes in total) at 2 pps (pulse per second), 20 ms, and 80V in 2006 and was revised as 6 positions, 12 minutes, 5 pps, 10 ms, and 90 V in 2009. Transcutaneous Electrical Nerve Stimulation electrodes of 5x5 cm

were used throughout the whole process. On the completion of the study, it was reported that there was a mean pain reduction of 6.1 in the NRS score in 10 patients, and this reduction lasted longer than three months. Pain relief lasted less than three months in two further patients, while pain did not decrease at all in three patients. The authors emphasized that there were still questions concerning the optimal electrode position, TPRF settings (e.g., voltage), number of positions, treatment duration, and frequency and number of treatment sessions, which should be addressed by controlled studies.

Chard et al. investigated shoulder disorders in elderly and 644 patients (318 male, 326 female) were included in the study (14). At least 70% of the shoulder disorders primarily involved the rotator cuff. The duration of current shoulder pain varied from 1 month to many years (1-120 months). The level of pain experienced during shoulder movement was mild in 52 subjects, moderate in 54, and severe in 30. Pain at night was a problem in 93 patients, and pain at rest occured in 65. Disability experienced by the patients due to the shoulder condition included washing and personal care in 83, hosehold chores in 73, and difficulty with lifting and doing tasks above shoulder height in 108. This study shows that shoulder pain is a painful pathology for the elderly as well. In this study, Chard did not mention the treatment modalities preferred in the elderly and which one is more effective in the elderly. In our study, there was an age difference between the groups, but the effect of this on our study is unknown. If the combined group had been younger, like the other group, there might have been a difference between the 3rd month results.

There are some limitations of our study, such as being prospective, not having only TPRF group, and age difference between groups. As Taverner emphasizes, prospective, randomized studies are needed to standardize TPRF duration, number of positions, voltage, RF frequency, interval between sessions, and number of sessions. In addition, prospective and larger case series are needed to further evaluate the efficacy of combined therapy. There is also a need for studies comparing the methods applied to reduce shoulder pain in the elderly.

Applying TPRF for longer periods or in repeated sessions may further increase the efficacy of treatment. However, there are still many issues concerning the lack of standardization of the duration of application, number of positions, voltage, RF frequency, interval between sessions, and number of sessions.

CONCLUSION

Transcutaneous pulsed RF and PRFSN are effective methods in the treatment of shoulder pain. Both methods are effective, reliable, and easy to implement. In this study, it was determined that the analgesic effect was prolonged when a single session of TPRF was added to PRFSN after a short-term steroid treatment. Therefore, we recommend the use of combined RF rather than PRFSN alone.

AUTHOR CONTRIBUTIONS

Conception or design of the work: CY

Data collection: CY, GK

Data analysis and interpretation: GK

Drafting the article: CY

Critical revision of the article: GK

All authors (CY, GK) reviewed the results and approved the final version of the manuscript.

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