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Comparison between effects of radial extracorporeal shock wave therapy and progressive resistive exercise in treatments of chronic lateral elbow tendinosis

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Background : *Elbow tendinosis is the most common cause of elbow pain. Both radial extracorporeal shock wave therapy (rESWT) and progressive resistive exercise (PRE) are widely used and share evidences of effectiveness in treating elbow tendinosis. So far, there have not been any evidence that confirms better effectiveness of one treatment over the other.*

Objective : *To compare the effects between rESWT and PRE in chronic lateral elbow tendinosis regarding the improvement of pain, The Disabilities of the Arm, Shoulder and Hand (DASH) score, pressure pain threshold and pain-free handgrip strength.*

Methods : *Eighteen chronic lateral elbow tendinosis patients that had failed other conservative treatment. rESWT group underwent rESWT for 5 sessions, once a week, whereas PRE group did progressive resistive exercise using elastic band. Both groups met the researcher weekly for treatment sessions for 5 weeks; then continued their home exercise until 12 weeks. VAS pain score at rest, during activities, at night, during provocative test, DASH score, pressure pain threshold (PPT) and pain-free handgrip strength (PFHGS) were assessed at baseline, and 3, 6 and 12 weeks after starting treatment.*

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Results : *The rESWT group demonstrated significant improvement of pain during activities (P = 0.005, 0.001,<0.001), pain at night (P = 0.035, 0.040, 0.008), pain during provocative test (P = 0.012, 0.011, <0.001), PPT (P = 0.025, 0.013, <0.001) and DASH score (P = 0.017, 0.004, <0.001)) at 3, 6 and 12 weeks, PFHGS at 6 and 12 weeks (P = 0.011, <0.001). The PRE group significantly improved pain during activities (P = 0.004), pain during provocative test (P = 0.001), and DASH score (P = 0.021) at 12 weeks. At 12 weeks, rESWT significantly improved pain during activities (P = 0.042), DASH score (P = 0.038), PPT (P = 0.002), and PFHGS (P = 0.013) when compared with PRE.*

Conclusion : *rESWT results in greater improvement of pain during activities, DASH score, pressure pain threshold, and pain-free hand grip strength than PRE in patients with chronic lateral elbow tendinosis. rESWT can improve pain at rest, at night and during provocative test compared to the baseline but it shows no significant benefit over PRE in these parameters.*

Keywords : *Radial extracorporeal shockwave therapy, progressive resistive exercise, elbow tendinosis.*

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วรวรรณ ซุ้นสุวรรณ, สริสสา แรงกล้า. การศึกษาเปรียบเทียบผลการใช้ radial extracorporeal shock wave therapy กับ progressive resistive exercise ในการรักษาภาวะเส้นเอ็นข้อศอกด้านนอกเสื่อมเรื้อรัง. จุฬาลงกรณ์เวชสาร 2560 มี.ค. – เม.ย; 61(2): 193 – 204

เหตุผลการทำวิจัย : *ภาวะเส้นเอ็นข้อศอกเสื่อมเป็นสาเหตุที่พบบ่อยที่สุดของอาการปวดบริเวณข้อศอก ในปัจจุบันการบำบัดด้วย radial extracorporeal shock wave therapy (rESWT) และ progressive resistive exercise (PRE) เป็นการรักษาที่ใช้กันอย่างแพร่หลายและมีหลักฐานว่ามีประสิทธิภาพในการรักษาภาวะนี้ได้ดี แต่ยังไม่มีหลักฐานชี้ชัดว่าการรักษาใดได้ผลดีกว่ากัน*

วัตถุประสงค์ : *เพื่อเปรียบเทียบผลของการรักษาโดยวิธีใช้ rESWT เพื่อรักษาภาวะเส้นเอ็นข้อศอกด้านนอกเสื่อมเรื้อรังกับใช้ PRE ในการลดอาการปวดจากปัญหาการใช้งาน การกดเจ็บ และเพิ่มแรงบีบมือ*

วิธีการทำวิจัย : *ผู้ป่วยเส้นเอ็นข้อศอกด้านนอกเสื่อมเรื้อรัง รักษาด้วยวิธีอนุรักษ์อื่นแล้วไม่ดีขึ้น จำนวน 18 ราย ทำการสุ่มแบ่งผู้ป่วยเป็น 2 กลุ่ม กลุ่มการรักษาด้วย rESWT และกลุ่มการรักษาด้วย PRE โดยใช้ elastic band ซึ่งผู้ป่วยทั้ง 2 กลุ่มมารับการรักษา 1 ครั้ง/สัปดาห์ เป็นเวลา 5 สัปดาห์ เมื่อออกกำลังต่อเนื่องจนครบ 12 สัปดาห์ ทำการประเมินความเจ็บปวด (visual analogue scale, VAS) และประเมิน disability of the arm, shoulder and hand (DASH) การกดเจ็บแรงบีบมือที่มากที่สุด โดยที่ไม่เจ็บที่ก่อนการรักษาในสัปดาห์ที่ 3, 6 และ 12*

ผลการศึกษา : *การรักษาด้วย rESWT สามารถลดความปวดขณะทำกิจกรรม (P = 0.005, 0.001,<0.001) ความปวดก่อนนอน (P = 0.035, 0.040, 0.008) ความปวดขณะทำ provocative test (P = 0.012, 0.011, <0.001) เพิ่มแรงกดเจ็บ (P = 0.025, 0.013, <0.001) และคะแนน DASH (P = 0.017, 0.004, <0.001) ที่ 3, 6 และ 12 สัปดาห์ตามลำดับ และเพิ่มแรงบีบมือ (P = 0.011, <0.001) ที่ 6 และ 12 สัปดาห์ ในขณะที่ PRE สามารถลดความปวดขณะทำกิจกรรม (P = 0.004) ความปวดขณะทำ provocative test (P = 0.001) และคะแนน DASH (P = 0.021) ที่ 12 สัปดาห์ เมื่อทำการเปรียบเทียบความแตกต่างของทั้ง 2 วิธีที่ 12 สัปดาห์ พบว่าการรักษาด้วย rESWT สามารถลดความปวดขณะทำกิจกรรม (P = 0.042) คะแนน DASH (P = 0.038) เพิ่มแรงกดเจ็บ (P = 0.002) และแรงบีบมือ (P = 0.013) ได้มากกว่า PRE อย่างมีนัยสำคัญทางสถิติ*

สรุป : *การรักษาด้วย rESWT สามารถลดความปวดขณะทำกิจกรรม ปัญหาการใช้งานการกดเจ็บและเพิ่มแรงบีบมือได้ดีกว่าการรักษาด้วย PRE นอกจากนี้ การรักษาด้วย rESWT สามารถลดอาการปวดก่อนนอน และขณะทำ provocative test เมื่อเทียบกับก่อนการรักษา แต่ไม่มีความแตกต่างทางสถิติเมื่อเทียบกับการรักษาด้วย PRE*

คำสำคัญ : *ภาวะเส้นเอ็นข้อศอกเสื่อม, การออกกำลัง, PRE, rESWT.*

Elbow tendinosis is the most common cause of elbow pain. The incidence of lateral elbow tendinosis is 1- 3% per year[1], most common in the age group between 40 - 50 years.[2] The most common tendon involved is extensor carpiradialis tendon. This condition is related to repetitive use of the tendon which promotes ischemia and oxygen deprivation[1,3], causing release of pain mediators and tendon degeneration.[2, 4] In patients with chronic elbow pain which reduce usage of muscles involved, the muscles were found degenerated and regenerated.[5]

Clinical findings of lateral elbow tendinosis are usually pain at the common extensor tendon insertion at the lateral epicondyle.[1,2] The pain may be at rest or during activities. Physical examination can reveal tenderness at the lateral epicondyle. Special tests that confirm the diagnosis include Cozen's test, Mills' tennis elbow test, and Maudsley's test.[1,6] There is no data on advantage of these tests over each other. Radiographic investigation, however, is not essential for diagnosis.[6]

Treatments for this condition include reducing provocative activities,non-steroidal anti-inflammatory drugs (NSAIDs), stretching and strengthening exercises, braces, acupuncture, physical modalities such as low level laser therapy (LLLT)[7], ultrasound diathermy, transcutaneous electrical stimulation (TENS), iontophoresis, extracorporeal shock wave therapy (ESWT), local steroid injection, nitroglycerine patch, autologous blood injection, platelet-rich plasma injection[1, 2], botulinum toxin injection[4] and surgery.[6] There is no definite evidence whether any of these treatments are more beneficial than the others.[6 - 8] However, in chronic stage there are evidences that eccentric strengthening exercise can reduce pain and heal the tendon fibers; thus improves its function. Pienimaki TT, *et al*. studied PRE and found that it could reduce more pain and increase more function compared with ultrasound therapy.[9] Since there is no standard protocol for exercise in lateral elbow tendinosis, we use the same protocol as Pienimaki TT, *et al*. in this study. The protocol is also consistent with that of Stanish, Curwin and Alfredson which are widely used in the treatments of the condition.[10]

Extracorporeal Shock Wave therapy (ESWT) is believed to use the mechanical energy of shock wave to create cell change and tissue injury which induce tissue repair.[11] rESWT reveals some evidences regarding the effectiveness on pain reduction, grip strength improvement and DASH score over placebo,[12] In this study, we compared the effects of rESWT to PRE program which is now considered a standard program at our hospital.

Methods

Inclusion criteria: patients age > 25 years, pain at the lateral epicondyle for at least 3 months, unilateral lesion, initial visual analogue scale (VAS) > 40/100, tender at the lateral epicondyle, Cozen's test positive, having been treated with other conservative treatments and the pain does not decrease below VAS 40/100, given awash out period of 6 weeks after steroid injection, 4 weeks after physical modalities, and 1 week after NSAIDs.

Exclusion criteria: Lateral and medial elbow pain in the same arm, history of surgery, fracture or dislocation in the involved limb, having any contraindication to rESWT.

Participants who met inclusion and exclusion criteria were randomized into rESWT or PRE groups

using randomization blocks with allocation concealment. Both groups were similarly advised on their activities limitation.

PRE group: exercise program consisted of passive wrist flexion with ulnar deviation for 30 seconds, 3 times, before and after strengthening exercise, and isometric strengthening wrist extensor muscles for 10 seconds,10 times/set, 3 sets/session, 2 sessions/day. When the participant can do isometric exercise without pain, they are to progress to isotonic exercise using elastic band. (Sanct B and, peach color, resistant force at 100% stretched = 1.3 kg) Participants are to grasp elastic band and slowly extend and flex the wrist, using resistance as to feel slightly fatigue at 10 times, exercise 10 times/set, 3 sets/session, 2 sessions/day. Having taken exercise for 2 days, if the participant feels no fatigue and can move the elastic band easily, they are to take progress resistance by shorten the band 1 inch. This is to be repeated every 2 days. If the progression of resistance caused more pain, they are to return to the previous resistance and be reevaluated after 2 days. If there is no pain during the exercise, they are to keep in progress the resistance again. Participants continue exercise for 12 weeks and record their exercise in log books. Participants are requested to meet the researcher once a week in the first 5 weeks to remind and check the accuracy of the program.

rESWT group: Participants were advised to do passive stretching and isometric exercise, same as the PRE group. Participants are to take radial extracorporeal shock wave therapy (Swiss Dolorclast, Electro Medical Systems, Switzerland), energy flux density 0.05 - 0.35 mJ/mm^2. Participants are to sit with shoulder 45°abduction, elbow 90° flexion, forearm parallel to the floor. Gel is to be applied on treatment area, at the point perpendicular to the skin; using pressure 1.2 bar, 4 Hz, 500 shots at the most tender point. Then, pressure 1 bar, 10Hz, 1,500 shots at wrist/finger extensor muscle group. rESWT is performed 1 session/week, 5 sessions. Participants are to continue passive stretching and isometric exercise and record in log books for 12 weeks.

Outcome measurement

Demographic data were recorded at baseline. Outcomes were assessed before treatment and at 3 weeks, 6 weeks and 12 weeks after treatment onset by the researcher who was blinded to the treatment the participants were receiving. Pain at rest, during activities, at bedtime and with provocative test were assessed using visual analogue scale (VAS) 100 mm, score 0 - 100. Assess arm function with Disability of the arm, shoulder and hand (DASH), Thai version. Pain threshold algometry was assessed by increasing pressure on the tender point until the participant felt pain, recorded 3 times and average. Pain-free hand grip strength using Jamar hand dynamometer was assessed while the participants were standing with elbow fully extended, arm close to the trunk, palm inward to the trunk. They are to compress the dynamometer until pain is felt, recorded 3 times and average. Adverse events and management were recorded. Patient's satisfaction was assessed at 12 weeks using visual analogue scale 0 – 100.

Statistical analysis

The data were analyzed using SPSS version 17.0. Within-group analysis of results at 3, 6 and 12 weeks after treatment onset comparing with baseline

was calculated using repeated ANOVA and post hoc analysis with Bonferroni method. Between-group analysis was calculated using Mann Whitney U test and ANCOVA adjusted for baseline difference. *P* value <0.05 were considered statistically significant.

The rESWT group demonstrated significant improvement of all parameters except pain at rest at 3, 6 and 12 weeks after starting treatment, whereas the PRE group reduced only pain during activities, pain during provocative test and DASH score at 12 weeks.

Results

CONSORT Diagram

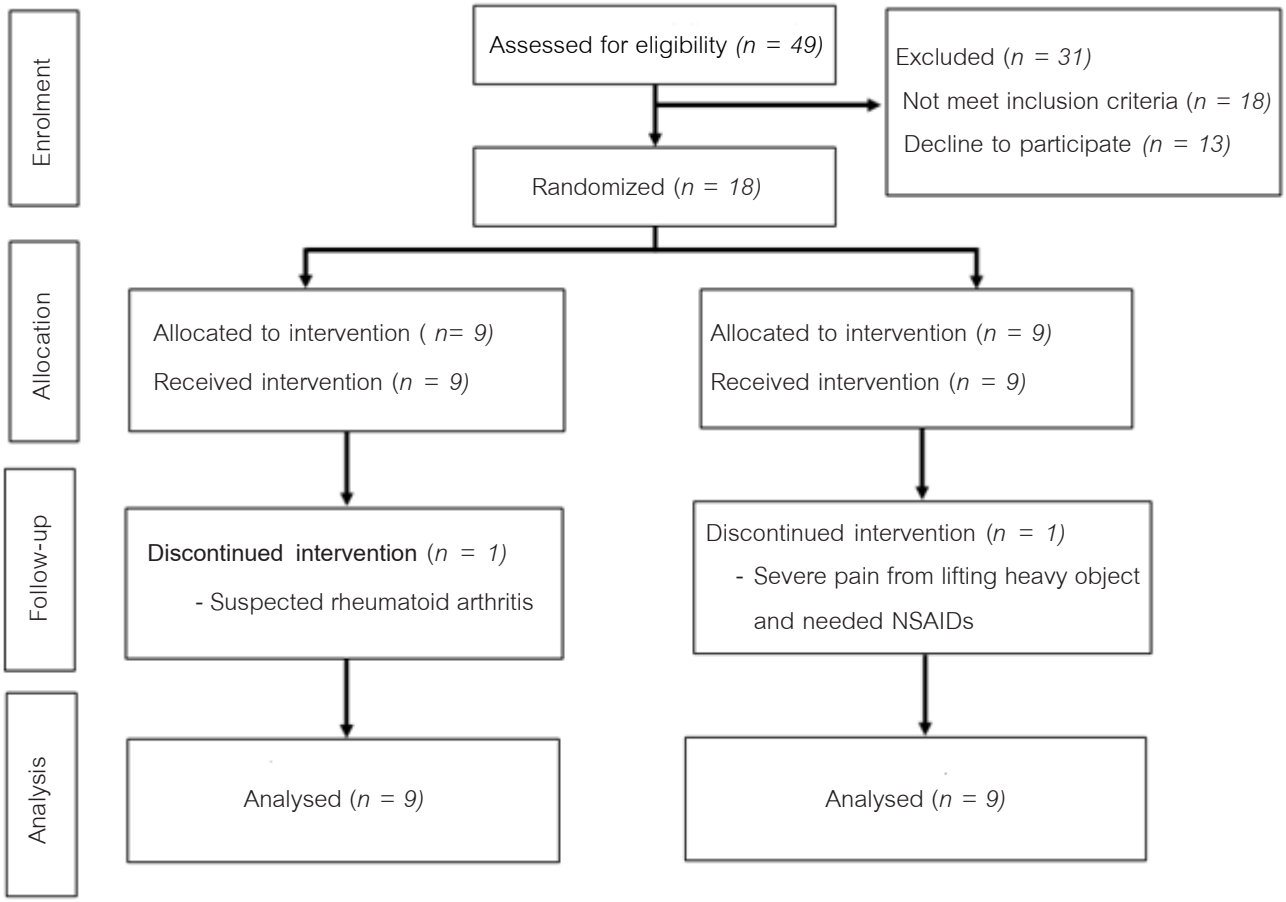

Table1. Baseline characteristics of subjects in this study.

Characteristics	rESWT (n = 9)	PRE (n = 9)
Age (y)	47.3 ± 5.4	52.0 ± 5.7
Women	7 (88)	7 (88)
BMI (kg/m2)	22.8 ± 3.2	24.9 ± 4.1
Study on dominant hand	5 (63)	5 (63)
Smoker	0	0
Duration of symptom (mo)	6.1 ± 4.7	7.1 ± 3.8
Trigger point	1 (11)	0 (0)
VAS of pain at rest (100)	35.2 ± 23.9	31.7 ± 33.0
VAS of pain at activity (100)	71.6 ± 18.4	55.6 ± 27.3
VAS of pain at night (100)	40.9 ± 22.2	32.4 ± 32.6
VAS of pain at provocative test (100)	66.7 ± 26.9	75.3 ± 23.9
DASH score (100)	47 ± 20	40 ± 14
PPT	1.9 ± 0.4	2.5 ± 1
PFHGS	10.4 ± 6.3	13.7 ± 10.6

NOTE. Values are mean ± SD, n (%), n

VAS (Visual Analogue Scale), DASH (Diability of Arm, Shoulder and Hand)

PPT (pressure pain treshold), PFHGS (pain-free handgrip strength)

Table 2. In group analysis of results at 3, 6 and 12 weeks after treatment onset comparing with baseline.

	Treatment Groups					
	rESWT (n = 9)			PRE (n = 9)		
Measures	**mean ± SD**	**median IQR (25, 75)**	***P* value†**	**mean ± SD**	**median IQR (25, 75)**	***P* value†**
VAS of pain at rest (100)						
Pretreatment	35.2 ± 25.2	40 (13, 52)		31.7 ± 33.0	24 (3, 66)	
After 3 weeks	16.2 ± 19.2	7(2, 25)	0.284	17.9 ± 18.2	18 (2, 34)	0.832
After 6 weeks	9.2 ± 20.4	0 (0, 11)	0.172	11.7 ± 11.3	9 (2, 25)	0.505
Posttreatment	4.9 ± 10.5	0 (0, 6)	0.048*	4.7 ± 8.9	0 (0, 8)	0.099
VAS of pain at activity (100)						
Pretreatment	71.6 ± 18.4	64 (56, 90)		55.6 ± 27.3	68 (33, 79)	
After 3 weeks	33.9 ± 24.9	30 (9, 55)	0.005*	36.5 ± 34.4	30 (7, 75)	0.330
After 6 weeks	22.1 ± 23.8	13 (8, 34)	0.001*	33.0 ± 27.3	34 (5, 55)	0.246
Posttreatment	8.7 ± 12.1	3 (0,16)	<0.001*	21.3 ± 24.6	12 (3, 33)	0.004*

Table 2. (Con) In group analysis of results at 3, 6 and 12 weeks after treatment onset comparing with baseline.

	Treatment Groups					
	rESWT (n = 9)			PRE (n = 9)		
Measures	**mean ± SD**	**median IQR (25, 75)**	***P* value†**	**mean ± SD**	**median IQR (25, 75)**	***P* value†**
VAS of pain at night (100)						
Pretreatment	40.9 ± 22.7	48 (21,60)		32.4 ± 32.6	25 (7,60)	
After 3 weeks	12.7 ± 20.0	4 (0,19)	0.035*	16.9 ± 24.7	10 (3,19)	0.603
After 6 weeks	9.8 ± 21.1	0 (0,13)	0.040*	9.8 ± 10.4	10 (0,19)	0.224
Posttreatment	3.9 ± 10.2	0 (0,2)	0.008*	5.1 ± 8.5	0 (0,11)	0.068
VAS of pain at provocative test (100)						
Pretreatment	66.7 ± 26.9	76 (44, 87)		75.3 ± 23.9	85 (57, 92)	
After 3 weeks	30.8 ± 21.1	36 (9, 41)	0.012*	54.1 ± 34.9	50 (23, 87)	0.278
After 6 weeks	23.5 ± 28.5	12 (1, 41)	0.011*	41.5 ± 33.0	37 (11, 68)	0.061
Posttreatment	7.3 ± 10.9	0 (0, 20)	<0.001*	22.6 ± 31.4	7 (3, 32)	0.001*
DASH score (100)						
Pretreatment	47 ± 20	47 (29, 66)		40 ± 14	43 (27, 51)	
After 3 weeks	28 ± 21	28 (13, 32)	0.017*	32 ± 17	33 (15, 50)	0.904
After 6 weeks	21 ± 21	10 (8, 33)	0.004*	25 ± 16	23 (10, 40)	0.167
Posttreatment	11 ± 13	7 (4,11)	<0.001*	20 ± 14	13 (10, 36)	0.021*
PPT						
Pretreatment	1.9 ± 0.4	2.0 (1.48, 2.29)		2.5 ± 1.0	2.1 (2.0, 3.2)	
After 3 weeks	2.8 ± 1.0	3.2 (1.90, 3.65)	0.025*	2.1 ± 0.5	2.1 (1.7, 2.4)	1.000
After 6 weeks	3.0 ± 1.2	3.0 (2.12, 4.22)	0.013*	2.8 ± 0.9	2.4 (2.0, 3.8)	1.000
Posttreatment	4.0 ± 1.3	4.5 (2.72, 4.79)	<0.001*	2.8 ± 0.8	2.4 (2.1, 3.6)	1.000
PFFHGS						
Pretreatment	10.4 ± 5.3	11.7 (5,14)		13.7 ± 10.6	12.5 (4, 22)	
After 3 weeks	18.5 ± 8.4	17.5 (14, 20)	0.023*	15.0 ± 9.3	11.8 (8, 22)	1.000
After 6 weeks	19.5 ± 7.3	19.5 (15, 20)	0.01*	17.3 ± 8.2	18.5 (12, 22)	0.549
Posttreatment	22.3 ± 7.0	21.0 (18, 29)	0.012*	17.4 ± 8.2	16.8 (13, 24)	0.613

† Repeated ANOVA with post-Hoc analysis test for within-group analysis; * *P* value is <0.05 defined significant. VAS (Visual Analogue Scale), DASH (Disability of Arm, Shoulder and Hand). PPT (pressure pain threshold), PFHGS (pain-free handgrip strength).

Table 3. Between group intention-to-treat analysis.

Measures	Treatment Groups rESWT (n = 9)	PRE (n = 9)	MWU†	Mean of Between-Group Difference (mean ± SE) Independen *t* test
VAS of pain at rest (100)				
Pretreatment	35.2 ± 23.9	31.7 ± 33		
Posttreatment	4.9 ± 10.5	4.7 ± 8.9		
Change	30.3 ± 25.5	26.9 ± 34.2		
P value (95% CI)			0.564	
VAS of pain at activity (100)				
Pretreatment	71.6 ± 18.4	55.6 ± 27.3		
Posttreatment	33.9 ± 24.9	21.3 ± 24.6		
Change	63.0 ± 17.0	34.2 ± 30.0		
P value (95% CI)			0.042*	
VAS of pain at night (100)				
Pretreatment	40.9 ± 22.2	32.4 ± 32.6		
Posttreatment	3.9 ± 10.2	5.1 ± 8.5		
Change	37.0 ± 21.2	27.3 ± 40.0		
P value (95% CI)			0.232	
VAS of pain at Cozen's test (100)				
Pretreatment	66.7 ± 26.9	75.3 ± 23.9		
Posttreatment	7.3 ± 10.9	22.6 ± 31.4		
Change	59.0 ± 31.8	52.2 ± 32.2		
P value (95% CI)			0.479	
DASH score (100)				
Pretreatment	47 ± 20	40 ± 14		
Posttreatment	11 ± 13	20 ± 14		
Change	36 ± 18	19 ± 16		
p value (95% CI)			0.038*	
PPT				
Pretreatment	1.9 ± 0.4	2.5 ± 1		
Posttreatment	4.0 ± 1.3	2.8 ± 0.8		
Change	2.0 ± 0.9	0.3 ± 0.8		
P value (95% CI)			0.002*	
PFHGS				
Pretreatment	10.4 ± 6.3	13.7 ± 10.6		
Posttreatment	22.6 ± 7.3	17.4 ± 8.2		
Change	12.1 ± 6.7	3.7 ± 6.1		6.8 ± 3.4
P value (95% CI)				0.013* (2.05 to 14.83)

NOTE. Values are mean ± SD or as otherwise indicated.

MWU† : Mann-Whitney U test for between group analysis

**P* value is <0.05 defined significant.

Comparing between the two groups, rESWT showed significantly greater improvement of pain during activities, DASH score, pressure pain threshold, and pain-free hand grip strength than PRE group.

Treatment satisfaction was 97 ± 5 in the rESWT group and 93 ± 9 in the PRE group. There is no statistical significant difference between the two groups (P = 0.24).

Discussion

rESWT can improve pain, DASH score, and pain-free hand grip strength in patient with chronic lateral elbow tendinosis, the same as in Specca G, *et al*.[12] The proposed mechanisms of pain reduction may be by stunning the nerve endings, which can produce early pain reduction. Then the tissue repairing process take place and take care of the remaining pain.

PRE can reduce pain during activities and pain during provocative test, like in the study by Pienimaki TT, *et al*.[9], but it shows no significant difference regarding pain at rest and pain-free hand grip strength. This may be because the baseline pain at rest in our study was rather low. Also, our participants exercised only 2 sessions/day, while their participants exercised 4 - 6 sessions/day.

When compared between the two groups, rESWT can improve greater pain and functions than PRE. The effects were also earlier, as early as 3 weeks after starting treatment. This early pain reduction, in addition to being beneficial in itself, it can increase patient's compliance. Also, this benefit may allow higher intensity and duration of exercise. Therefore, combining rESWT with PRE may be an interesting option. Further study is, however, required to confirm whether combined rESWT and exerciseis more effective than rESWT alone in patients with chronic lateralelbow tendinosis.

This study compared two treatments which are widely used in practice and considered standard program in our hospital. The results showed some benefit of rESWT over PRE, which can help physicians and patients make decision regarding choices of treatment. However, limitation of this study is that the small number of participants may be not enough to elicit significant difference in some area, and also caused baseline difference between group after randomization which required statistical adjustment.

Conclusion

rESWT results in greater improvement of pain during activities, DASH score, pressure pain threshold, and pain-free hand grip strength than PRE in patients with chronic lateral elbow tendinosis. rESWT can improve pain at night and during provocative test comparing to baseline, but it shows no significant benefit over PRE in these parameters.

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