Acta Orthop. Belg., 2020, **86 e-SUPPLEMENT** 1, 161-168

ORIGINAL STUDY

Comparison of corticosteroid injection and ozone injection for relief of pain in chronic lateral epicondylitis

R. Gökhan ULUSOY, Ali BILGE, Ömür ÖZTÜRK

From the Department of Orthopaedics and Traumatology, Kafkas University, Kars, Turkey

To evaluate and compare the therapeutic effects of corticosteroid and ozone injections in the alleviation of pain associated with chronic lateral epicondylitis . Data was collected from the medical records of 80 patients (56 women, 24 men; average age: 45.8±7.5). Corticosteroid injection was performed once a week for three times, and ozone was injected 6-8 times at 3 day intervals. No additional analgesics were given. Pain assessment was made by means of Verhaar scores before and after the first injection, on 3rd, 6th and 9th months.

The duration of pain was 24.4±12.5 months and the right side was more commonly affected (47, 58.8% vs. 33, 41.2%). Corticosteroid and ozone groups were similar with respect to age (p=0.45), gender distribution (p=0.43) and side of epicondylitis (p=0.88). Pain scores at rest, at compression and on activity were not different in two groups before and following injection. Notably, ozone group displayed better scores compared to corticosteroid in terms of pain on 3rd, 6th and 9th months after injection (p<0.001 for all).

Our results demonstrated that ozone injection can be an effective therapeutic option for CLE patients who are refractory to conservative treatment.

Keywords: Chronic lateral epicondylitis ; injection ; corticosteroid ; ozone.

INTRODUCTION

Lateral epicondylitis is a frequent and painful disorder of the elbow attributed to the enthesopathy of the common extensor origin. It is also termed as "tennis elbow" and occurs in 1–3 % of the general population. Women and men are affected, and the age range is 35-55 years *(5,19)*. The pathology of lateral epicondylitis is related with inflammation, microrupture and degeneration due to repetitive trauma. Histologically, degenerative angiogenesis is followed by fibrosis and calcification *(10)*. Pain is more prominent on the extension of the wrist and is aggravated by repetitive and forceful activity *(22)*.

The treatment of chronic lateral epicondylitis (CLE) involves rest, modification of activity, nonsteroidal anti-inflammatory medications, splints, physiotherapy, extracorporeal shock wave therapy, and corticosteroid or botulinum toxin injections *(5,16)*. All of these treatment modalities have been investigated, and various degrees of clinical benefit have been documented *(10)*. Non-surgical treatment is usually sufficient for the

■ R Gökhan Ulusoy[1].
■ Ali Bilge[1].
■ Ömür Öztürk[2].
[1]*Department of Orthopaedics and Traumatology, Kafkas University, Kars, Turkey*
[2]*Department of Anesthesiology and Reanimation, Kafkas University, Kars, Turkey*
Correspondence: Asst. Prof.R Gökhan Ulusoy, Department of Orthopedics and Traumatology, Kafkas University, Kars, Turkey, Phone: +90 545 4575773, Fax: +90 474 2251195
E-mail : ulusoyg@hotmail.com

Conflict of interest: All authors declare that they have not received any funding or other benefits in support of this study. No relevant financial relationships to disclose.

majority of patients with CLE, and approximately 90 % of patients recover without any surgical procedure *(7)*. The target of injection treatment is the common extensor origin and various substances such as corticosteroids, platelet-rich plasma and autologous blood have been utilized in this purpose *(5,11)*. Injection of corticosteroids into the area with maximal tenderness has been performed as an effective and preferential mode of treatment for a long time *(23,11)*. Comparison of corticosteroid injection and physical therapy yielded that patients receiving corticosteroid injection had better results in terms of pain relief, patient satisfaction, and grip strength *(25)*.

However, relevant publications yielded that recurrence of symptoms was not rare after the initial alleviation or disappearance of symptoms after corticosteroid injection *(22,10,23,11)*. Thus, in spite of its well-documented usefulness in short-term, there is controversy on the benefits of corticosteroid injection in the long term.

The goals of treatment in CLE involve reduction in pain, preservation of motion, flexibility, and strength, and improved endurance. Non-surgical management, which consists of physical therapy, activity modification, nonsteroidal anti-inflammatory drugs and injections, is the mainstay of management that results in improvement for the majority of patients *(7)*.

Ozone has been used in various conditions for management of pain, and it is supposed to serve as a complementary and low-risk mode of treatment *(1,4)*. To the best of our knowledge, no publications have been made on the efficacy of ozone injection for the management of pain ensourcing from CLE. Intraarticular ozone injections have yielded a rapid and effective alleviation of pain in acute and chronic painful diseases of joints. Thus, it may be a preferable and adjunctive method to anti-inflammatory treatment with rapid onset of action, subsidence of swelling, reduction in temperature and improvement of joint mobility. Its beneficial effects on knee osteoarthrosis, low back pain, and lumbar sciatic pain have been well established *(1,9)*. Furthermore, the sharp decrease in pain due to ozone therapy may be sustained for a longer time *(4)*.

The objective of the current study was to outline the characteristics of patients with CLE and to comparatively evaluate the efficacy of corticosteroid and ozone injections for relief of pain in these patients.

MATERIALS

This retrospective cohort study was performed on data extracted from the medical files of patients treated in the orthopaedics and traumatology department of our institution between 2014 and 2016. The approval of local Institutional Review Board was provided prior to the study.

Our series was comprised of eighty cases (56 women, 24 men) diagnosed with unilateral CLE. These patients did not have any benefit from conservative treatment involving restriction of activity, cold compression and non-steroidal anti-inflammatory drugs (NSAIDs) in the preceding 3 months.

The inclusion criteria were age between 25 to 60 years, body mass index <30 kg/m^2, normal blood test results and coagulation profile. Exclusion criteria consisted of systemic or metabolic disease, history of surgery for lateral epicondylitis, previous injections for CLE, arthritis, effusion around the elbow, entrapment of the ulnar nerve, peri-articular fracture, infection or trauma involving lateral epicondylar region, bone tumor involving distal humerus and increased erythrocyte sedimentation rate. All participants reported pain and tenderness over the extensor origin on the forearm, a positive chair test with pain on lateral epicondyle when the chair is lifted with one hand in a position with the forearm pronated and the wrist is in flexion *(14)*. Positive Mills' sign is defined as the occurrence of pain in the lateral epicondyle if the elbow is moved from flexion to complete an extension with the forearm in the prone position and the wrist in flexion *(13)*.

The baseline characteristics in each group including the gender, age, dominant and affected sides were recorded. Pain at rest, on compression and during activity was examined before and after the injection of corticosteroid or ozone, and on 3rd, 6th and 9th months. Results were categorized as

excellent, good, fair, or poor according to modified Verhaar criteria (pain relief, patient satisfaction, grip strength, the presence of provoked pain on resisted wrist extension) *(24)*. According to the criteria of Verhaar et al., therapeutic outcomes was defined as; 'excellent' (no pain, patient contented with the treatment result, no subjective loss of grip strength and no pain exacerbated by resisted dorsiflexion of the wrist), 'good' (symptoms considerably decreased, patient satisfied with the treatment outcome, occasional mild pain on the lateral epicondyle after heavy activities, no or slight subjective loss of grip power, and no pain aggravated by resisted dorsiflexion of the wrist), 'fair' (discomfort on the lateral epicondyle after strenuous activities but at a more tolerable than before treatment, patient satisfied or moderately satisfied with the outcome of treatment, slight or moderate subjective loss of grip strength, and slight or moderate pain provoked by resisted dorsiflexion of the wrist), or 'poor' (no decrease of pain of the lateral epicondyle, patient disappointed with the result of treatment, serious subjective loss of grip strength and severe pain exacerbated by resisted dorsiflexion of the wrist) *(24)*. Treatment was considered successful when the patient had an excellent or a good score.

Corticosteroid and ozone injection groups were compared in terms of baseline descriptive data and pain scores on different intervals (Tables I and II).

Injections were performed after aseptic preparation at the attachment site of common extensor tendon on the lateral epicondyle. No additional medications were given, or no restriction of activity was recommended.

For corticosteroid injection, we used the technique described by Altay et al. *(2)*. The patient was in supine position on the examination table with the elbow in 90° flexion and neutral rotation position. Using an 18-gauge needle, 1 ml of betamethasone dipropionate (6.43 mg) and betamethasone sodium phosphate (2.63 mg) (Diprospan®, Merck Sharp Dohme Pharmaceuticals, Levent, Istanbul, Turkey) was injected. The injection finished following the cessation of the sensation of a crepitus or cracking, which was felt at the beginning. The needle should be inserted lightly to avoid damage to its tip upon contact with the bone.

The production of ozone (O_3) from O_2 was made at a concentration of 30 µg/ml. Aliquots of 1 ml (10 µg) was applied 6-8 times with 3-day intervals. The injection procedure of ozone was performed in accordance with the relevant literature *(12)*.

Our data was analyzed by means of IBM Statistical Package for Social Sciences (SPSS) Statistics 20 software (SPSS Inc., Chicago, IL, USA). Normality of distribution for variables was tested via Kolmogorov Smirnov test. Variables with normal distribution were evaluated with parametric tests, while non-parametric tests were utilized for variables without normal distribution. Any correlation between variables was evaluated with Pearson Correlation test. Comparison of two groups for variables with normal distribution was performed with Independent-Samples t test, while

Table I. — An overview of baseline descriptive and clinical information of our series

Variable		Treatment group		p-value
Corticosteroid injection		Ozone injection		
Gender	Women	25 (65.8%)	31 (73.8%)	
	Men	13 (34.2%)	11 (26.2%)	0.43
Age (years)		46.4±6.8	45.1±8.1	0.45
Dominant side (R/L)		36/2	39.3	0.73
Affected side (R/L)		22/16	25/17	0.88
Duration of pain (months)		23.6±12.3	25.1±12.8	0.60

(Abbreviations: R: right; L: left)

Table II. — Comparison of corticosteroid and ozone injection groups in terms of pain scores on different intervals

Time interval	Condition during evaluation of pain	Modified Verhaar score	Treatment group		p-value
			Corticosteroid n, (%)	Ozone n, (%)	
Before injection	At rest	Excellent	0	0	
		Good	0	1 (2.4)	
		Fair	2 (5.3)	3 (7.1)	
		Poor	36 (94.7)	38 (90.5)	0.59
	On compression	Excellent	0	0	
		Good	0	1 (2.4)	
		Fair	2 (5.3)	3 (7.1)	
		Poor	36 (94.7)	38 (90.5)	0.59
	During activity	Excellent	0	0	
		Good	0	1 (2.4)	
		Fair	2 (5.3)	3 (7.1)	
		Poor	36 (94.7)	38 (90.5)	0.59
After injection	At rest	Excellent	20 (52.6)	21 (50)	
		Good	9 (23.7)	15 (35.7)	
		Fair	3 (7.9)	5 (11.9)	
		Poor	6 (15.8)	1 (2.4)	0.14
	On compression	Excellent	20 (52.6)	18 (42.9)	
		Good	8 (21.1)	15 (35.7)	0.073
		Fair	4 (10.5)	8 (19.0)	
		Poor	6 (15.8)	1 (2.4)	
	During activity	Excellent	20 (52.6)	18 (42.9)	
		Good	8 (21.1)	14 (33.3)	0.070
		Fair	4 (10.5)	9 (21.4)	
		Poor	6 (15.8)	1 (2.4)	
3rd month after injection	At rest	Excellent	10 (26.3)	25 (59.5)	
		Good	9 (23.7)	14 (33.3)	<0.001*
		Fair	10 (26.3)	2 (4.8)	
		Poor	9 (23.7)	1 (2.4)	
	On compression	Excellent	10 (26.3)	23 (54.8)	
		Good	9 (23.7)	15 (35.7)	<0.001*
		Fair	10 (26.3)	3 (7.1)	
		Poor	9 (23.7)	1 (2.4)	
	During activity	Excellent	10 (26.3)	22 (52.4)	
		Good	9 (23.7)	16 (38.1)	<0.001*
		Fair	10 (26.3)	3 (7.1)	
		Poor	9 (23.7)	1 (2.4)	

6th month after injection	At rest	Excellent	9 (23.7)	24 (57.1)	<0.001*
		Good	7 (18.4)	15 (35.7)	
		Fair	9 (23.7)	2 (4.8)	
		Poor	13 (34.2)	1 (2.4)	
	On compression	Excellent	7 (18.4)	16 (38.1)	<0.001*
		Good	7 (18.4)	2 (4.8)	
		Fair	11 (28.9)	2 (4.8)	
		Poor	13 (34.2)	22 (52.4)	
	During activity	Excellent	8 (21.1)	22 (52.4)	<0.001*
		Good	7 (18.4)	16 (38.1)	
		Fair	10 (26.3)	2 (4.8)	
		Poor	13 (34.2)	2 (4.8)	
9th month after injection	At rest	Excellent	8 (21.1)	24 (57.1)	<0.001*
		Good	7 (18.4)	15 (35.7)	
		Fair	6 (15.8)	1 (2.4)	
		Poor	17 (44.7)	2 (4.8)	
	On compression	Excellent	7 (18.4)	21 (50)	<0.001*
		Good	6 (15.8)	16 (38.1)	
		Fair	7 (18.4)	3 (7.1)	
		Poor	18 (47.4)	2 (4.8)	
	During activity	Excellent	8 (21.1)	20 (47.6)	<0.001*
		Good	5 (13.2)	16 (38.1)	
		Fair	7 (18.4)	4 (9.6)	
		Poor	18 (47.4)	2 (4.8)	

(Abbreviations : *: statistically significant

comparison of two categorical variables was carried out with Pearson Chi-Square test. Quantitative data was expressed as mean, standard deviation, median, interquartile range as well as minimum and maximum values. Confidence interval was 95% and p value less than 0.05 was considered as statistically significant.

RESULTS

Our series was composed of 80 patients (56 women, 70%; 24 men, 30%) with an average age of 45.8±7.5 years (range: 28 to 58). The average duration of pain due to CLE was 27.4±12.5 months (range: 6 to 48). The right side was dominant in the majority of cases (75, 93.8%) and CLE was more commonly detected on the right side (47, 58.8%). Of the 80 patients, 38 (47.5%) were treated with corticosteroid injection, while 42 (52.5%) received ozone injection.

The average age of patients in corticosteroid (n=38) and ozone (n=42) injection groups did not differ remarkably with respect to age (46.4±6.9 versus 45.1±8.1; p=0.45). Similarly, the duration of pain (24.0-24.0 versus 24.0-24.0-24.0; p=0.60) and distribution of gender (p=0.43) were similar in both groups. In both groups, the right side was more likely to be dominant (p= 0.73) and was more commonly affected by CLE (p=0.88). An overview of baseline descriptive and clinical data is presented in Table I.

Before the injection procedure, there was no difference between corticosteroid and ozone groups with respect to pain scores at rest, on compression and during activity (p=0.59 for all).

Evaluation of pain scores just after the injections yielded that two groups had similar results with respect to the pain score at rest (p=0.14), on compression (p=0.07), and during activity (p=0.07). Interestingly, analysis of pain on 3rd, 6th and 9th months after injections demonstrated that ozone group had significantly better scores at rest (p<0.001), on compression (p<0.001) and during activity (p<0.001). Table II demonstrates the

comparative scores of pain at rest, on compression and during activity at different time intervals in corticosteroid and ozone injection groups.

We observed no complications such as remarkable pain, necrosis or tendon rupture during or after injection of corticosteroids and ozone.

DISCUSSION

The objective of the present study was to compare the pain killing effects of corticosteroid and ozone injections in CLE patients who were refractory to conservative treatment. Our results indicated that ozone injection provided a more effective and long lasting relief of pain. This beneficial effect of ozone supports its widespread therapeutic use for CLE. However, further high-quality research on larger series is needed for standardization of treatment protocols and determination of indications and drawbacks.

Chronic lateral epicondylitis is a painful, inflammatory and degenerative disease of common extensor tendon due to overuse. Even though some publications report that men and women are equally affected *(5,21)*, we noted that women were more frequently vulnerable for CLE . In conjunction with relevant literature, we observed that people greater than 40 years of age are more likely to be affected *(26)*.

CLE not only causes pain, but it also leads to loss of function at the elbow. Therefore, reduction of activity and absence from work are likely. Even though there is increased knowledge about tendinopathy, the pathophysiology of CLE is under debate. None of the numerous therapeutic options is universally effective. Corticosteroid injections have been frequently used owing to their low-cost and practicality, but they are particularly useful in short-term *(23,18,8)*. Our findings related with the effect of corticosteroid injection is consistent with these publications, and we suggest that injection of corticosteroid provides only a temporary relief of pain. There is inadequate or even conflicting evidence on the preferable mode of treatment for CLE. In this context, ozone injection may constitute an effective, safe and practical option with durable painkilling action. Even though the efficacy of ozone treatment for spine and joint osteoarthritis and low back pain has been well documented *(1,4,12,20)*, its use in CLE has not been previously reported. Increased availability of ozone and high safety profile encourage its use for CLE.

We noted that right side was dominant in 93.8% of CLE patients, but CLE was diagnosed on the right side in only 58.8% of patients. This finding is noteworthy, because CLE not necessarily involves the dominant side and it can be speculated that not only overuse but also postural habits, lifestyle, and genetic predisposition may be responsible for the development of CLE.

Our results support that corticosteroid injection provided a better short-term outcome on pain with no significant advantage in the long term. This may be attributed to the fact that CLE is a degenerative disorder of the extensor tendon origin rather than an inflammatory condition *(21)*. This degeneration may be facilitated by the contact and abrasion of extensor carpi radialis brevis tendon during elbow movement *(21)*.

No serious adverse events were encountered after injection of corticosteroids or ozone and safety of these procedures may favour popularization of injection treatment for CLE. Corticosteroid injection is particularly useless for patients with chronic or refractory CLE *(6)*. We think that selection of patients and the substance to be injected must be made with respect to the analysis of patient history with emphasis on the success rate of previous treatment regimens.

In parallel to our findings, Sims et al. reported that corticosteroids provided only short-term relief up to several months, and this effect was not sustained in long-term *(22)*. Other modes of treatment including bracing or physical treatment seem not to provide any substantial benefit *(22)*. Based on this data, we suggest that corticosteroid injection must be reserved for acute relief of pain in patients who are –at least partially- responsive to conservative treatment. It must be considered that corticosteroid injection may result in degeneration of the tendon *(16)*.

The effect of ozone on the recovery of symptoms may be associated with alteration of the biochemical

composition in the target tissue. This change may lead to the elimination of toxic metabolites produced by inflammation and degeneration. Furthermore, ozone may elicit the migration of fibroblasts and lymphocytes to the site of disease *(4,20)*. In this manner, production and release of irritant substances onto the sensitive ganglia may be inhibited *(4)*. Enhancement of vascularization at the level of cartilaginous plates and promotion of neo-angiogenesis by means of ozone treatment may reduce ischemia, hypoxia, and inflammation at the target tissue. Furthermore, ozone treatment may display an antiseptic and antibacterial action *(4)*.

Ozone treatment may activate protective enzymes against degeneration triggered by overproduction of oxygen radicals *(1)*. The chemical bonds created between ozone and water may diminish the concentration of oxidants. Moreover, anti-inflammatory and painkilling actions of ozone may modify the microenvironment and reduction status of hemoglobin leading to improvement of oxygen availability *(1)*.

Our findings remind that minimally invasive treatments such as percutaneous injections offer good clinical results combined with a well-tolerated, practical procedure for CLE. Ozone injection safely and effectively relieves pain ensourcing from CLE. The possible mechanism of action may be linked with immunomodulatory, analgesic and anti-inflammatory effects of ozone.

Weaknesses of the present study include lack of a control group, small sample size, and retrospective design must be remembered during interpretation of our results. Furthermore, only pain was assessed, and functional restoration was not taken into account. Our data is confined to the experience of a single institution and social, environmental, genetic factors as well as personal variability for pain perception may influence our results. Longer follow-up period may provide more accurate and reliable data.

To conclude, our results demonstrated that ozone injection can be a safe and effective therapeutic option with long-lasting effect for CLE patients who are refractory to conservative treatment. Further prospective, controlled trials on larger series are warranted to set the protocols and elucidate the indications and drawbacks of ozone treatment in the management of CLE.

REFERENCES

1. **Al-Jaziri AA, Mahmoodi SM.** Painkilling effect of ozone-oxygen injection on spine and joint osteoarthritis. *Saudi Med J.* 2008 ; 29 : 553-557.
2. **Altay T, Gunal I, Ozturk H.** Local injection treatment for lateral epicondylitis. *Clin Orthop Relat Res* 2002 ; 398 : 127-130.
3. **Andreula CF, Simonetti L, De Santis F, Agati R, Ricci R, Leonardi M.** Minimally invasive oxygen-ozone therapy for lumbar disk herniation. *AJNR Am J Neuroradiol.* 2003 ; 24 : 996-1000.
4. **Apuzzo D, Giotti C, Pasqualetti P, Ferrazza P, Soldati P, Zucco GM.** An observational retrospective/horizontal study to compare oxygen-ozone therapy and/or global postural re-education in complicated chronic low back pain. *Funct Neurol.* 2014 ; 29 : 31-39.
5. **Arirachakaran A, Sukthuayat A, Sisayanarane T, Laoratanavoraphong S, Kanchanatawan W, Kongtharvonskul J.** Platelet-rich plasma versus autologous blood versus steroid injection in lateral epicondylitis: systematic review and network meta-analysis. *J Orthop Traumatol.* 2016 ;17 : 101-112.
6. **Behrens SB, Deren ME, Matson AP, Bruce B, Green A.** A review of modern management of lateral epicondylitis. *Phys Sportsmed.* 2012 ; 40 : 34-40.
7. **Beyazal MS, Devrimsel G.** Comparison of the effectiveness of local corticosteroid injection and extracorporeal shock wave therapy in patients with lateral epicondylitis. *J Phys Ther Sci.* 2015 ; 27 : 3755-3758.
8. **Coombes BK, Bisset L, Vicenzino B.** Efficacy and safety of corticosteroid injections and other injections for management of tendinopathy: A systematic review of randomised controlled trials. *Lancet* 2010 ; 376 : 1751-1767.
9. **D'Erme M, Scarchilli A, Artale AM.** Ozone therapy in lumbar sciatic pain. *Radiol Med.*1998 ; 95 : 21-24.
10. **De Smedt T, de Jong A, Van Leemput W, Lieven D, Van Glabbeek F.** Lateral epicondylitis in tennis: update on aetiology, biomechanics and treatment. *Br J Sports Med* 2007 ; 41 : 816-9.
11. **Dogramaci Y, Kalaci A, Savaş N, Duman IG, Yanat AN.** Treatment of lateral epicondilitis using three different local injection modalities: a randomized prospective clinical trial. *Arch Orthop Trauma Surg.* 2009 ; 129 : 1409-1414.
12. **Duymus TM, Mutlu S, Dernek B, Komur B, Aydogmus S, Kesiktas FN.** Choice of intra-articular injection in treatment of knee osteoarthritis: platelet-rich plasma, hyaluronic acid or ozone options. *Knee Surg Sports Traumatol Arthrosc.* 2016 Apr 7.
13. **Friedlander HL, Reid RL, Cape RF.** Tennis elbow. *Clin Orthop Relat Res* 1967 ; 51 : 109-116.

14. **Gardner RC.** Tennis elbow: diagnosis, pathology and treatment: nine severe cases treated by a new reconstructive operation. *Clin Orthop Relat Res* 1970 ; 72 : 248-253.
15. **Gaujoux-Viala C, Dougados M, Gossec L.** Efficacy and safety of steroid injections for shoulder and elbow tendonitis: A metaanalysis of randomised controlled trials. *Ann Rheum Dis* 2009 ; 68 : 1843-1849.
16. **Gautam VK, Verma S, Batra S, Bhatnagar N, Arora S.** Platelet-rich plasma versus corticosteroid injection for recalcitrant lateral epicondylitis: clinical and ultrasonographic evaluation. *J Orthop Surg* (Hong Kong). 2015 ; 23 : 1-5.
17. **Giombini A, Menotti F, Di Cesare A** *et al.* Comparison between intrarticular injection of hyaluronic acid, oxygen ozone, and the combination of both in the treatment of knee osteoarthrosis. *J Biol Regul Homeost Agents.* 2016 ; 30 : 621-625.
18. **Lewis M, Hay EM, Paterson SM, Croft P.** Local steroid injections for tennis elbow: Does the pain get worse before it gets better? Results from a randomized controlled trial. *Clin J Pain* 2005 ; 21 : 330-334.
19. **Ozden R, Uruç V, Doğramaci Y, Kalaci A, Yengil E.** Management of tennis elbow with topical glyceryl trinitrate. *Acta Orthop Traumatol Turc.* 2014 ; 48 : 175-80.
20. **Paoloni M, Di Sante L, Cacchio A** *et al.* Intramuscular oxygen-ozone therapy in the treatment of acute back pain with lumbar disc herniation: a multicenter, randomized, double-blind, clinical trial of active and simulated lumbar paravertebral injection. *Spine* (Phila Pa 1976). 2009 ; 34 : 1337-1344.
21. **Qian X, Lin Q, Wei K, Hu B, Jing P, Wang J.** Efficacy and safety of autologous blood products compared with corticosteroid injections in the treatment of lateral epicondylitis: a meta-analysis of randomized controlled trials. *PM R.* 2016 ; Mar 9.
22. **Sims SE, Miller K, Elfar JC, Hammert WC.** Non-surgical treatment of lateral epicondylitis: a systematic review of randomized controlled trials. *Hand* (N Y). 2014 ; 9 : 419-446.
23. **Tonks JH, Pai SK, Murali SR.** Steroid injection therapy is the best conservative treatment for lateral epicondylitis: a prospective randomised controlled trial. *Int J Clin Pract.* 2007 ; 61 : 240-246.
24. **Verhaar J, Walenkamp G, Kester A, van Mameren H, van der Linden T.** Lateral extensor release for tennis elbow. A prospective long-term follow-up study. *J Bone Joint Surg Am* 1993 ; 75 : 1034-43.
25. **Verhaar JA.** Tennis elbow. Anatomical, epidemiological and therapeutic aspects. *Int Orthop* 1994 ; 18 : 263-267.
26. **Weber C, Thai V, Neuheuser K, Groover K, Christ O.** Efficacy of physical therapy for the treatment of lateral epicondylitis: a meta-analysis. *BMC Musculoskelet Disord.* 2015 ; 16 : 223.