

Platelet-Rich Plasma Is an Equal Alternative to Surgery in the Treatment of Type 1 Medial Epicondylitis

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Background: Medial epicondylitis (ME) is characterized as an overuse injury resulting in pathological alterations of the common flexor tendon at the elbow. Platelet-rich plasma (PRP) has recently become of interest in the treatment of musculoskeletal conditions as an alternative to operative management.

Purpose: To compare the outcomes of recalcitrant type 1 ME after treatment with either PRP or surgery.

Study Design: Cohort study; Level of evidence, 3.

Methods: To compare the 2 methods of treatment, we performed a retrospective review of 33 patients diagnosed with type 1 ME from 2006 to 2016 with a minimum clinical follow-up of 1 year who had failed an initial nonoperative treatment program of injections, medication, topical creams, and/or physical therapy. Overall, 15 patients were treated with a series of 2 leukocyte-rich PRP injections, and 18 patients were treated with surgery. Outcome measures included time to pain-free status, time to full range of motion (ROM), the Mayo Elbow Performance Score (MEPS), and the Oxford Elbow Score (OES). Each patient had at least 1-year follow-up. They were then contacted by telephone to determine final scores at a minimum 2-year follow-up. Unsuccessful outcomes were determined by the Nirschl grading system and failure to reach pain-free status, achieve baseline ROM, or return to previous activity.

Results: The mean final follow-up was 3.9 years. A statistically significant improvement was noted in both time to full ROM (42.3 days for PRP vs 96.1 days for surgery; $P < .01$) and time to pain-free status (56.2 days for PRP vs 108.0 days for surgery; $P < .01$). Successful outcomes were observed in 80% of patients treated with PRP and 94% of those treated operatively ($P = .37$). No significant difference was found in return-to-activity rates, overall successful outcomes, MEPS scores, or OES scores.

Conclusion: In this case series, the use of PRP showed clinically similar outcomes to those of surgery in recalcitrant type 1 ME. PRP can be considered as an alternative to surgery in the treatment of recurrent ME, with an earlier time to full ROM and time to pain-free status compared with surgery.

Keywords: medial epicondylitis; platelet-rich plasma; elbow; tendinitis

Medial epicondylitis (ME), commonly referred to as “golfer’s elbow,” is caused by a pathological alteration of the musculotendinous origin of the common flexor tendon (CFT) at the medial epicondyle from overuse. Similar to its lateral counterpart, ME typically arises in the fourth and fifth decades of life but occurs with a much lower incidence.^{14,23,29} It has been shown to have a greater association with occupations than with sports, with forceful work being a greater risk factor than repetitive work alone.^{7,18,23,29} Although some studies have shown that nonoperative treatment is often successful in relieving pain and inflammation, a greater proportion of patients with

ME required surgery than patients with lateral epicondylitis (12% vs 4%, respectively).¹⁸ It is important to classify ME into type 1 or type 2. Type 1, with no involvement of the ulnar nerve, has a more successful outcome with nonoperative treatment than type 2, which usually requires surgery.¹⁵

The medial epicondyle serves as the attachment for the CFT, a confluence of the pronator teres, palmaris longus, flexor carpi radialis, flexor carpi ulnaris, and flexor digitorum superficialis. In addition to flexor-pronator functions, this group of muscles provides dynamic stability to the elbow.^{10,20,25} Overuse of the elbow, creating a valgus force, leads to microtrauma to the flexor-pronator group that attaches to the medial epicondyle.^{8,10,25} Most often, the pronator teres and flexor carpi radialis are affected, but ME can involve all muscles in the flexor-pronator group.²

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Patients will present with pain on the medial side of their elbow that is exacerbated by resisted forearm pronation and wrist flexion. Maximal tenderness can be located 5 mm distal and anterior to the midpoint of the medial epicondyle, correlating with the location of the CFT relative to the medial epicondyle.¹⁰

Nonoperative treatment is the mainstay for the management of ME, with a resolution of symptoms seen in roughly 90% of type 1 cases.²⁶ Treatment in the nonoperative setting consists of activity modification, bracing, physical therapy, oral anti-inflammatory medication, and corticosteroid injections.² In cases refractory to nonoperative management for more than 6 months, operative treatment may be indicated.¹⁹ Surgical treatment for ME traditionally includes open debridement and release of the CFT or CFT repair; however, other arthroscopic and percutaneous techniques have been described.²

Injections of platelet-rich plasma (PRP) have recently become of interest in the management of musculoskeletal conditions. PRP is a solution of autologous blood that has been modified via plasmapheresis to significantly increase the concentration of platelets. This solution of platelets is rich in protein, growth factors, and other cellular components that are essential to the innate soft tissue healing process.¹⁶ PRP injections are currently being investigated for the treatment of rotator cuff tears, osteoarthritis, hamstring injuries, and various tendinopathies, including lateral epicondylitis.¹⁶ Preliminary studies for PRP treatment of lateral epicondylitis are encouraging, although large-scale and long-range studies are lacking.^{1,22} PRP injections have compared favorably with steroid injections for the short-term management of lateral epicondylitis and have been used successfully to treat cases that failed nonoperative management.^{1,5}

This retrospective case series aimed to compare the clinical outcomes of patients treated with PRP injections to those treated with open surgical debridement for recalcitrant type 1 ME.

METHODS

After institutional review board approval, a retrospective review was conducted of patients diagnosed with type 1 ME from 2006 to 2016. Patients were identified using Current Procedural Terminology, International Classification of Diseases–Ninth Revision and Tenth Revision codes. Patient charts were reviewed for the presence of concurrent ulnar nerve symptoms or positive electromyographic findings to distinguish between type 1 and type 2 ME. A total of

92 patients were diagnosed and treated for type 1 ME between 2006 and 2016. There were 33 patients in this cohort who failed nonoperative treatment and were included in this study. All patients were initially managed with nonoperative treatment for at least 3 months. If symptoms persisted, the diagnosis was confirmed with magnetic resonance imaging (MRI) and/or ultrasound. Evidence of degeneration of the flexor pronator tendon origin on ultrasound or MRI confirmed the diagnosis. Patients older than 16 years of age with isolated ME without concurrent ulnar neuritis were included. Exclusion criteria included clinical follow-up of less than 1 year and/or additional ipsilateral elbow injuries. Overall, 33 patients met the final criteria and were included in the review. These patients were given a choice between PRP injections or surgery for their next step in treatment. The risks and benefits of each treatment option as well as the differences in cost to the patient were discussed before selecting the treatment option. The out-of-pocket expense was approximately US\$325 per PRP injection, for a total cost to the patient of US\$650 in our treatment protocol. Ultimately, 15 patients underwent a series of 2 leukocyte-rich PRP injections, and 18 were treated operatively.

The protocol for PRP included refraining from nonsteroidal anti-inflammatory drugs for at least 1 week before and during treatment. A series of 2 PRP injections were performed 2 to 3 weeks apart while continuing a home exercise program and cryocompression therapy. The PRP preparation was as follows: The patient's unaffected arm was prepared for blood draw at the start of his or her appointment, and 54 mL of blood was subsequently harvested from the antecubital fossa using the APC-60 Procedure Pack (Terumo BCT). This was combined with 6 mL of ACD-A anticoagulant to create a total volume of 60 mL. The blood was processed and concentrated on-site using the Harvest SmartPrep Multicellular Processing System (Terumo BCT). The spin time and rate were as follows: The machine accelerated to 2500 rpm over 2 minutes and then underwent the first spin cycle at 2500 ± 150 rpm for 4 minutes. The machine then slowed to 0 rpm and accelerated back up to 2300 rpm over the subsequent 3 minutes. The second spin cycle then took place for 3 minutes at 2300 ± 140 rpm. The machine took 2 minutes to decelerate to a stop, completing the process. The total cycle time was roughly 14 minutes. This process created a final volume of 4 to 7 mL of leukocyte-rich plasma with a target platelet concentration of 1500 × 10⁹/L. After processing, the prepared solution was returned to the patient's room for injection.

Injections were performed with the patient supine and his or her hand resting comfortably with the arm abducted and hand supinated. Ultrasound guidance was used to find

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the pathological site. The needle was then advanced under ultrasound guidance to the level of the bone and slowly withdrawn while injecting PRP. At 1 month after the second injection, MRI or ultrasound was performed to evaluate tendon integrity, and activity was allowed to increase as tolerated.

The surgical procedure, described in detail by Wu et al,³⁰ began with a small T-type incision with open debridement of the damaged tendon. Repair was then performed using a single 1.9-mm, double-loaded, all-suture suture anchor (Suturefix Ultra; Smith & Nephew). This anchor was placed on the anterior aspect of the medial epicondyle just medial to the attachment of the medial ulnar collateral ligament. Double-row T-type tendon repair was performed by pulling the anterior flaps down through the anchor, followed by pulling the posterior flap over the debrided medial epicondyle. Each patient was immobilized in a cast for 1 week and underwent a dual bracing (wrist and elbow) program for an additional 3 to 5 weeks. Physical therapy was initiated around 3 weeks and continued for an additional 3.5 to 5 months.

At final clinical follow-up (mean, 3.9 years), each patient was classified according to the Nirschl grading system.¹⁷ An excellent outcome was recorded when the patient returned to full activity with no pain. A good outcome was considered when the patient returned to full activity with only occasional mild pain. A patient was marked with a fair rating if he or she had pain due to strenuous or heavy activity or was unable to return to his or her previous activity level. A fail rating was given when the patient received no pain relief from the intervention. Per the original scoring system, an outcome was considered "successful" if the patient received a good or excellent rating.

Patients were followed clinically for a minimum of 1 year, with each patient returning for visits at 2 weeks, 6 weeks, 3 months, and 1 year after the intervention. Additional visits were scheduled at the discretion of the treating surgeon between 3 months and 1 year, if necessary. Pain level and range of motion (ROM) were recorded at each follow-up visit. Pain levels were calculated using a visual analog scale (VAS; range, 0-10). The difference in VAS scores from before to after the intervention was also recorded. In this study, we reviewed time to pain-free status and time to full ROM. The Mayo Elbow Performance Score (MEPS; range, 0-100) and Oxford Elbow Score (OES; range, 0-48) were administered at the time of the final telephone interview.

The Student *t* test was used for comparison between groups. Statistical significance was determined using an alpha level of 0.05. An ad hoc power analysis was performed using a beta level of 0.8 and a clinically significant difference in mean successful outcomes of 15%. This calculation yielded an ideal sample size of 82 participants to achieve a power level of 0.8.

RESULTS

A total of 33 patients failed nonoperative treatment and were included in our study. Ultimately, 55% (18/33) of these patients received surgery and 45% (15/33) received PRP

TABLE 1
Demographic Characteristics and Outcomes^a

	Operative Group (n = 18)	PRP Group (n = 15)	P
Demographics			
Age, y	47.1	37.5	.08
Male sex, n (%)	12 (67)	12 (80)	.12
Outcome measures			
Successful on Nirschl grading system, n (%)	17 (94)	12 (80)	.37
Improvement on VAS	4.7	3.7	.12
MEPS (maximum, 100)	93.5	92.3	.30
OES (maximum, 48)	42.2	45.9	.18
Time to full ROM, d	96.1	42.3	<.01
Time to pain-free status, d	108.0	56.2	<.01

^aData are shown as the mean unless otherwise indicated. MEPS, Mayo Elbow Performance Score; OES, Oxford Elbow Score; PRP, platelet-rich plasma; ROM, range of motion; VAS, visual analog scale.

treatment. Overall, 80% (12/15) of the PRP group and 94% (17/18) of the operative group achieved a successful outcome according to the Nirschl grading system.

Patients in the operative group underwent surgery at a mean age of 47.1 ± 12.3 years (range, 16-62 years). Male patients made up 67% of this group. Patients in the PRP group received injections at a mean age of 37.5 ± 16.8 years (range, 16-64 years). Male patients made up 80% of this group. Although there was a trend toward the PRP group being more male dominant and slightly younger, neither age nor sex was found to be significantly different between the 2 groups (*P* = .08 and .12, respectively).

Patients underwent a mean of 4.0 months (range, 1.5-25.9 months) of nonoperative management in the operative group and 6.3 months (range, 1.8-45.0 months) in the PRP group. The mean clinical follow-up for the operative group was 1.6 years, with a mean final follow-up of 3.5 years at the time of the telephone interview. The mean clinical follow-up for the PRP group was 1.9 years, with a mean final follow-up of 4.2 years at the time of the telephone interview.

As shown in Table 1, there was no statistical significance in most outcome measures between the operative and PRP groups. There was no significant difference in success rates based on the Nirschl grading system (*P* = .37). Table 2 illustrates the breakdown of the Nirschl grades. Both the operative and PRP groups demonstrated an improvement in pain levels based on the VAS (4.7 and 3.7, respectively); however, the difference in pain improvement was not found to be statistically significant (*P* = .12). The mean MEPS and OES scores were 93.5 and 42.2 for the operative group and 92.3 and 45.9 for the PRP group, respectively. Neither the MEPS (*P* = .30) nor the OES (*P* = .18) scores demonstrated a statistically significant difference for returning to work and/or activities for both groups.

We found a significant difference in time to full ROM and time to pain-free status between the operative and PRP

TABLE 2
Nirschl Grading System Outcomes^a

	Operative Group (n = 18)	PRP Group (n = 15)
Successful	17 (94)	12 (80)
Excellent	9 (50)	12 (80)
Good	8 (44)	0 (0)
Unsuccessful	1 (6)	3 (20)
Fair	1 (6)	3 (20)
Failure	0 (0)	0 (0)

^aData are shown as n (%). PRP, platelet-rich plasma.

groups (Table 1). The operative group had a mean of 96.1 days to full ROM, while the PRP group had a mean of 42.3 days to full ROM ($P < .01$). The operative group had a mean of 108.0 days to being pain-free, while the PRP group had a mean of 56.2 days ($P < .01$).

DISCUSSION

PRP has recently emerged as a potential treatment for various musculoskeletal conditions, as it has gained traction as a safe alternative to surgical management in patients who have exhausted nonoperative treatment options.¹⁶ Although data remain inconclusive regarding the efficacy of PRP, studies have shown that it compares favorably with steroid injections and surgery for a number of conditions. Thus, it remains an area of ongoing investigation in orthopaedics.^{1,5,16}

PRP has been used successfully to treat a number of tendinopathies, including lateral epicondylitis. Peerbooms et al²¹ published a randomized controlled trial comparing PRP with corticosteroid injections for the treatment of lateral epicondylitis in 100 patients. Their study found that PRP performed superiorly to steroid injections and reported successful outcomes in 73% of elbows treated with PRP. Success was defined as a 25% improvement in VAS and Disabilities of the Arm, Shoulder and Hand (DASH) scores at 1-year follow-up. Brkljac et al⁵ published a prospective series of 34 patients treated with PRP for recalcitrant lateral epicondylitis and identified successful outcomes in 88.2% of patients, defined as an improvement on the OES. The use of PRP for the treatment of other tendinopathies has also been studied. Vetrano et al²⁷ published a randomized controlled trial of 46 patients comparing PRP with extracorporeal shock wave therapy for patellar tendinitis. Although that study found no significant difference between the treatment groups, 91.3% of patients treated with PRP were reported to have successful outcomes. A randomized controlled trial of 75 patients comparing the use of PRP to corticosteroid injections for the treatment of gluteus medius and minimus tendinopathies was published by Fitzpatrick et al.⁹ That study concluded that PRP performed superiorly to corticosteroids, with 65.8% of patients achieving a full recovery and successful outcomes from PRP.

Ultimately, 80% of our patients with type 1 ME achieved a successful result with PRP injections, a figure that is

comparable with described results for other tendinopathies that have been successfully treated with PRP. One difficulty in comparing the efficacy of PRP for various musculoskeletal diseases is that criteria for a successful outcome vary among studies and abnormalities. A second is that the use of PRP varies among diseases. For example, PRP is studied as an adjunct to surgery in rotator cuff disease rather than a primary treatment as it is in other tendinopathies such as lateral epicondylitis.¹

Large-scale studies have been conducted regarding the use of PRP for lateral epicondylitis. Arirachakaran et al³ published a meta-analysis of 10 randomized controlled trials comparing corticosteroid injections to autologous blood and PRP injections for the treatment of lateral epicondylitis. That study found that PRP and autologous blood injections improved VAS and DASH scores more effectively than corticosteroid injections; however, autologous blood injections carried a higher risk of adverse effects than did PRP injections. Rodik and McDermott²² similarly published a review of 4 studies comparing the effects of PRP injections with alternative injection treatments for lateral epicondylitis. They concluded that PRP injections provided more favorable pain relief and higher functional outcomes than did whole blood or corticosteroid injections 1 to 2 years after injection. These high-powered studies indicate that PRP injections have a role in the treatment of lateral epicondylitis, suggesting that it could be used effectively to treat ME given the similarities of the 2 abnormalities. However, there are limited data evaluating the use of PRP for the treatment of ME.

Although many studies have compared PRP injections with other nonoperative interventions for lateral epicondylitis, very few studies have compared the results of PRP to more invasive techniques. Boden et al⁴ recently compared a Tenex procedure with PRP injections for both ME and lateral epicondylitis in 62 elbows. Their study reported significant improvement in QuickDASH (shortened version of the DASH score) and VAS pain scores for both groups but with no statistically significant difference between treatment modalities. Overall, 79.3% of patients treated with PRP injections reported satisfactory outcomes, which is comparable with our study in which 80% of patients were successfully treated with PRP. Their study did not distinguish between lateral epicondylitis and ME treatment groups, nor did it report data on time to symptom resolution. The PRP protocol in that study included 1 injection with leukocyte-poor PRP rather than 2 injections with leukocyte-rich PRP, as used in our study. Their study concluded that PRP is successful in treating recalcitrant ME and lateral epicondylitis and offers comparable results with more invasive procedures.

Given the lack of data regarding PRP treatment for medial ME and the lack of data comparing PRP with operative interventions for either ME or lateral epicondylitis, we sought to introduce data to the literature comparing PRP injections with surgery for type 1 ME. After the treatment of type 1 recalcitrant ME, both surgery and 2 leukocyte-rich PRP injections provided successful results in 29 of 33 elbows at final clinical follow-up. Both

treatments appear to have comparable results with fairly reliable recovery.

The most striking difference between our 2 groups proved to be the recovery time after the intervention. PRP injections outperformed surgery, with time to full ROM occurring a mean of 42.3 days for PRP versus 96.1 days for surgery ($P < .01$) and time to pain-free status occurring at a mean of 56.2 days for PRP versus 108.0 days for surgery ($P < .01$). It should be noted that patients in the operative group underwent a postoperative bracing protocol, which contributed to the delay in the resolution of symptoms. This highlights a key advantage of PRP treatment in that a strict immobilization protocol can be avoided, promoting the rapid resolution of symptoms and return to activity. Our data support that when effective, PRP injections provided a more rapid resolution of symptoms for recalcitrant type 1 ME than operative management. Additionally, these results appear to be lasting, as the mean MEPS and OES scores at long-term telephone follow-up were in the excellent range and were comparable between the operative and PRP groups. Because of these results, we feel that PRP injections for the treatment of type 1 ME are a reasonable option for those wishing to pursue further nonoperative interventions. Last, although the numbers are small, the 3 patients who failed the PRP injections were able to be managed surgically with a successful outcome, indicating that no adverse effects from PRP were present when the treatment was unsuccessful. Thus, our current protocol for patients with type 1 ME who fail initial nonoperative treatment is trying PRP before considering surgery.

There are limited data regarding the protocols for PRP. We followed a protocol that the senior author (F.H.S.) developed with other elbow injuries, using a series of 2 leukocyte-rich PRP injections separated by 2 to 3 weeks along with a home exercise and cryotherapy program. Results were not obtained regarding the efficacy of 1 versus 2 injections, nor was a third injection considered. We believe that 2 injections are more effective than 1 injection for inducing an optimal healing response. The optimal PRP injection protocol for this abnormality could be studied in the future.

Our study has notable limitations introducing unintended bias. First, this is a retrospective study, and as such, certain biases are unavoidable. We believe that recall bias was minimized because of patient data being recorded and maintained at regular intervals during clinical follow-up. A second limitation of our study is that it was not randomized or case-controlled. A control group would be helpful to determine how PRP or surgery affects the natural disease course for those who fail initial nonoperative management. A third significant limitation of our study is the relatively small sample size. ME has a very low incidence, making high-powered studies difficult to achieve. However, our case study is comparable in size with those previously published on the topic.^{6,11-13,24,28} Fourth, we note that PRP injections are frequently an out-of-pocket expense, and thus, treatment groups were self-selected by the patient. This may have created unintended selection bias regarding which patients received PRP injections versus surgery. Of note, our PRP group was younger, on average, than the

operative group. Although this was not determined to be statistically significant, this is likely because of the low power of our study and may have had an effect on final outcomes. A final limitation is that PRP content was determined by the preparation method and was not separately analyzed after preparation but before use. Future research on this topic would be benefited by a blinded, case-controlled prospective study in which more conclusive evidence could be obtained on the efficacy of PRP injections versus operative management for type 1 ME.

CONCLUSION

A series of 2 leukocyte-rich PRP injections is a comparable option in improving pain and overall function for recalcitrant type 1 ME. Surgery trended toward having a higher success rate than PRP (94% vs 80%, respectively); however, PRP was found to be comparable in final outcomes. When effective, the recovery time was shorter with a series of leukocyte-rich PRP injections than the recovery time from surgery, making this treatment a reasonable option in the management of type 1 ME.

REFERENCES

1. Ahmad Z, Brooks R, Kang SN, et al. The effect of platelet-rich plasma on clinical outcomes in lateral epicondylitis. *Arthroscopy*. 2013;29(11):1851-1862.
2. Amin NH, Kumar NS, Schickendantz MS. Medial epicondylitis: evaluation and management. *J Am Acad Orthop Surg*. 2015;23(6):348-355.
3. Arirachakaran A, Sukthuyat 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.
4. Boden AL, Scott MT, Dalwadi PP, Mauthner K, Mason RA, Gottschalk MB. Platelet-rich plasma versus Tenex in the treatment of medial and lateral epicondylitis. *J Shoulder Elbow Surg*. 2019;28(1):112-119.
5. Brkljac M, Kumar S, Kallo D, Hirehal K. The effect of platelet-rich plasma injection on lateral epicondylitis following failed conservative management. *J Orthop*. 2015;12(Suppl 2):S166-S170.
6. Cho BK, Kim YM, Kim DS, et al. Mini-open muscle resection procedure under local anesthesia for lateral and medial epicondylitis. *Clin Orthop Surg*. 2009;1(3):123-127.
7. Descatha A, Leclerc A, Chastang JF, Roquelaure Y. Study Group on Repetitive Work. Medial epicondylitis in occupational settings: prevalence, incidence and associated risk factors. *J Occup Environ Med*. 2003;45(9):993-1001.
8. Dlabach JA, Baker CL. Lateral and medial epicondylitis in the overhead athlete. *Oper Tech Orthop*. 2001;11(1):46-54.
9. Fitzpatrick J, Bulsara MK, O'Donnell J, Zheng MH. Leucocyte-rich platelet-rich plasma treatment of gluteus medius and minimus tendinopathy: a double-blind randomized controlled trial with 2-year follow-up. *Am J Sports Med*. 2019;47(5):1130-1137.
10. Glousman RE, Barron J, Jobe FW, et al. An electromyographic analysis of the elbow in normal and injured pitchers with medial collateral ligament insufficiency. *Am J Sports Med*. 1992;20:311-317.
11. Han SH, Lee JK, Kim HJ, Lee SH, Kim JW, Kim TS. The result of surgical treatment of medial epicondylitis: analysis with more than a 5-year follow-up. *J Shoulder Elbow Surg*. 2016;25(10):1704-1709.
12. Kurvers H, Verhaar J. The results of operative treatment of medial epicondylitis. *J Bone Joint Surg Am*. 1995;77(9):1374-1379.

13. Kwon BC, Kwon YS, Bae KJ. The fascial elevation and tendon origin resection technique for the treatment of chronic recalcitrant medial epicondylitis. *Am J Sports Med.* 2014;42(7):1731-1737.
14. Leach RE, Miller JK. Lateral and medial epicondylitis of the elbow. *Clin Sports Med.* 1987;6:259-272.
15. Morrey BF. *Master Techniques in Orthopaedic Surgery: The Elbow.* 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2014.
16. Mylnarek RA, Kugn AW, Bedi A. Platelet-rich plasma (PRP) in orthopedic sports medicine. *Am J Orthop.* 2016;45(5):290-326.
17. Nirschl RP, Pettrone FA. Tennis elbow: the surgical treatment of lateral epicondylitis. *J Bone Joint Surg Am.* 1979;61:832-839.
18. O'Dwyer KJ, Howie CR. Medial epicondylitis of the elbow. *Int Orthop.* 1995;19:69-71.
19. Ollivierre CO, Nirschl RP, Pettrone FA. Resection and repair for medial tennis elbow: a prospective analysis. *Am J Sports Med.* 1995;23(2):214-221.
20. Otoshi K, Kikuchi S, Shishido H, Konno S. The proximal origins of the flexor-pronator muscles and their role in the dynamic stabilization of the elbow joint: an anatomical study. *Surg Radiol Anat.* 2014;36(3):289-294.
21. Peerbooms JC, Sluimer J, Bruijn DJ, Gosens T. Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind randomized controlled trial: platelet-rich plasma versus corticosteroid injection with a 1-year follow-up. *Am J Sports Med.* 2010;38(2):255-262.
22. Rodik T, McDermott B. Platelet-rich plasma compared with other common injection therapies in the treatment of chronic lateral epicondylitis. *J Sport Rehabil.* 2016;25:77-82.
23. Shiri R, Viikari-Juntura E, Varonen H, Heliövaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. *Am J Epidemiol.* 2006;164(11):1065-1074.
24. Tasto JP, Richmond JM, Cummings JR, Hardesty R, Amiel D. Radio-frequency microtenotomy for elbow epicondylitis: midterm results. *Am J Orthop.* 2016;45(1):29.
25. Udall JH, Fitzpatrick MJ, McGarry MH, et al. Effects of flexor-pronator muscle loading on valgus stability of the elbow with an intact, stretched, and resected medial ulnar collateral ligament. *J Shoulder Elbow Surg.* 2009;18(5):773-778.
26. Vangsness CT, Jobe FW. Surgical treatment of medial epicondylitis. *J Bone Joint Surg Br.* 1991;73(3):409-411.
27. Vetrano M, Castorina A, Vulpiani MC, Baldini R, Pavan A, Ferretti A. Platelet-rich plasma versus focused shock waves in the treatment of jumper's knee in athletes. *Am J Sports Med.* 2013;41(4):795-803.
28. Wittenberg RH, Schaal S, Muhr G. Surgical treatment of persistent elbow epicondylitis. *Clin Orthop Relat Res.* 1992;(278):73-80.
29. Wolf JM, Mountcastle S, Burks R, Sturdivant RX, Owens BD. Epidemiology of lateral and medial epicondylitis in a military population. *Mil Med.* 2010;175(5):336-339.
30. Wu VJ, Thon SG, Finley Z, et al. Double row repair for recalcitrant medial epicondylitis. *Orthop J Sports Med.* 2019;12:2325967119885608.