Clinical and MRI Donor-Site Outcomes After Autograft Harvesting From the Medial Trochlea for Talar Osteochondral Lesions

Minimum 5-Year Clinical Follow-up

Changjun Guo,* MD, PhD, Xingchen Li,* MD, Yuan Zhu,* MD, Chonglin Yang,* MD, and Xiangyang Xu,*† MD, PhD

Investigation performed at Department of Orthopaedics, Rui Jin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

Background: Autologous osteochondral transplantation (AOT) is a treatment option for large or cystic osteochondral lesions of the talus (OLTs), with promising clinical results. However, donor-site morbidity (DSM) has always been a concern with this procedure.

Purpose: To investigate the clinical and radiological outcomes of autograft harvesting from the medial trochlea for OLTs.

Study Design: Case series; Level of evidence, 4.

Methods: A total of 46 consecutive patients were included after AOT procedures for OLTs, with donor autografts (single or double plugs) harvested from the medial trochlea of the ipsilateral knee. Lysholm scores were collected postoperatively at 12-month intervals to assess clinical outcomes. Postoperative magnetic resonance imaging (MRI) was used to assess the donor site using the MOCART (magnetic resonance observation of cartilage repair tissue) score. DSM was evaluated at 12-month intervals. Statistical analysis was performed to compare patients treated with single-plug and double-plug AOT procedures and establish whether there was any correlation between MOCART and Lysholm scores.

Results: The mean follow-up period was 98.3 months (range, 67-144 months). The Lysholm scores for all patients were 92.5 ± 6.1 and 99.9 ± 0.2 at the 12-month and final follow-ups, respectively. MRI of the donor sites was taken at an average of 93.8 ± 20.5 (range, 61-141) months postoperatively, and the mean MOCART score was 76.2 ± 4.9. The overall incidence of DSM in this study was 4.3% at 12 months, postoperatively, which decreased to 0% at the 24-month follow-up. There was no significant difference in either the Lysholm score ($P = .16$) or the MOCART score ($P = .83$) between the single-plug and double-plug groups at the final follow-up. There were no significant correlations between MOCART and Lysholm scores and patient age, number of grafts, or body mass index.

Conclusion: According to the study findings, the DSM of donor autografts harvested from the medial trochlea was low, and the number (single or double) of grafts did not affect the functional outcome.

Keywords: autologous osteochondral transplantation; donor-site morbidity; functional scores; MRI outcomes

Autologous osteochondral transplantation (AOT) is a primary treatment option for large or cystic osteochondral talar lesions.[23,28] AOT is a surgical procedure in which 1 or more cylindrical autografts of hyaline cartilage and subchondral bone are harvested from the ipsilateral knee and transplanted to talar lesions.[17] AOT involves fresh hyaline cartilage and has been reported to reliably and effectively provide functional improvement for large osteochondral talar lesions, with 90% of professional athletes returning to their preinjury sport level,[6,18] and more than 90% of patients from the general population returning to preinjury activities.[23]

Graft harvesting from an asymptomatic knee may induce donor-site morbidity (DSM) postoperatively, and authors have observed this concerning complication in AOT.[2,20] Many differences in the proportions of patients experiencing DSM after knee-to-talus AOT procedures have been reported.[5,7,9,27] A meta-analysis found that the DSM of knee to talus transplantation approached 11%.[24]

The Orthopaedic Journal of Sports Medicine, 10(9), 23259671221120075
DOI: 10.1177/23259671221120075

To decrease the morbidity of the donor site, the optimal donor site for graft harvesting is that with the lowest contact pressure. Of 75 international experts in cartilage repair of the ankle, 86% indicated that the lateral femoral condyle is the preferred osteochondral graft donor site.[11] However, there are some differences among the reported papers. The medial trochlea is a nonloadbearing site, and the preferred choice, followed by the intercondylar notch.[1] The medial trochlea has the lowest contact pressure, and osteochondral plugs from the medial femoral trochlea may be desirable.[8] Lee et al[14] reported effective clinical outcomes for autograft harvesting from the superomedial margin of the medial femoral condyle and transplanting of the grafts to talar lesions. Zhu and Xu[28] used the ipsilateral medial femoral condyle (proximal medial edge of the trochlea) during the AOT surgical procedure. However, the morbidity of cartilage autograft transplants harvested from the proximal medial edge of the trochlea has not been reported.

More than 1 plug is required for larger osteochondral talar lesions. Paul et al[19] reported that the clinical outcomes of the knee were not affected by the number of donor plugs or the size of the donor plugs. However, the donor plugs were harvested from the proximal lateral or medial femoral condyle, and no magnetic resonance imaging (MRI) of the donor sites was performed at final follow-up.[19] There is little evidence assessing the long-term clinical and radiological knee outcomes with different numbers of plugs harvested from the medial edge of the trochlea.

The purposes of this study were to (1) report the clinical and radiological knee outcomes of patients treated with cartilage autograft transplant from the proximal medial edge of the trochlea and (2) evaluate and compare clinical and radiological knee outcomes of patients who underwent single-plug and double-plug harvesting from the proximal medial edge of the trochlea.

METHODS

The protocol for this study was approved by our hospital ethics committee. We retrospectively analyzed the cases of 60 consecutive patients who had undergone AOT to treat a cartilage defect of the talus in our orthopaedic department between July 2009 and November 2015. Patients were included if they were older than 18 years, had symptomatic talar osteochondral lesions treated with AOT (either 1 or 2 grafts) at the time of reconstruction, had a Lysholm knee score of 100 preoperatively, had postoperative MOCART (magnetic resonance observation of cartilage repair tissue) scoring of the donor knee, and had a minimum 5-year follow-up. Exclusion criteria included a history of knee trauma or knee surgery, follow-up time shorter than 5 years, or the absence of MOCART scoring data for the donor knee during the postoperative follow-up period. Forty-six patients were included. The entire group of 46 patients included 19 women and 27 men with a mean age of 49.6 years (range, 18-66 years) at the time of surgery and a preoperative body mass index (BMI) of 25.6 kg/m^2 (range, 19.1-32.8 kg/m^2).

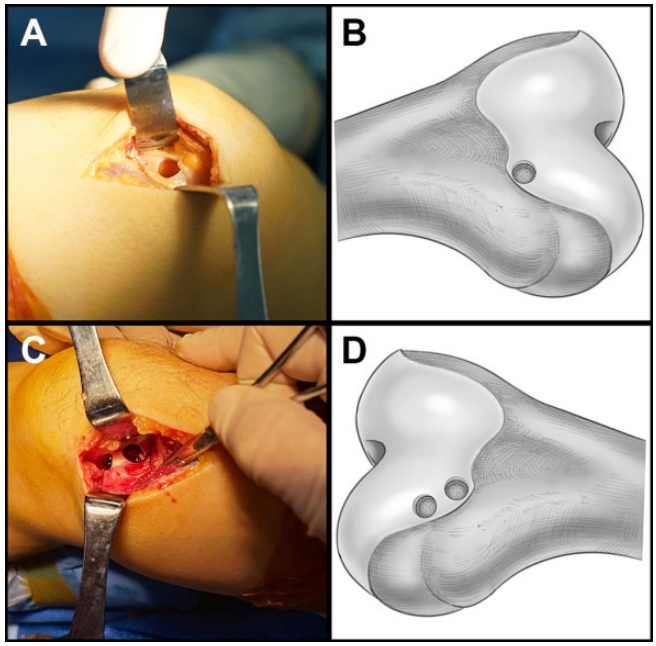

Figure 1. Intraoperative photograph and schematic drawing of the harvest site located on the proximal medial edge of the trochlea. (A, B) 1 plug. (C, D) 2 plugs.

We defined DSM as any disability at the knee donor site after autograft removal for talar osteochondral transplantation. Subjective donor-site symptoms, such as knee pain, locking, instability, or other complaints during the clinical follow-up period, were recorded. The Lysholm knee score representing knee function was recorded for all patients.[15] To evaluate how the clinical scores changed in the postoperative period, the scores were grouped according to 12-month intervals (0-12, 13-24, 25-36, 37-48, and >48 months postoperatively). The patients were contacted by telephone by a member of a neutral survey team to minimize bias in the recording of the results.

†Address correspondence to Xiangyang Xu, MD, PhD, Department of Orthopaedics, Rui Jin Hospital, Shanghai Jiao Tong University School of Medicine, 197 Ruijin Er Rd, Shanghai 20025, China (email: xu664531@126.com).
*Department of Orthopaedics, Rui Jin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China.
C.G. and X.L. contributed equally to this work
Final revision submitted April 27, 2022; accepted June 9, 2022.
The authors declared that there are no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.
Ethical approval for this study was obtained from Rui Jin Hospital North.

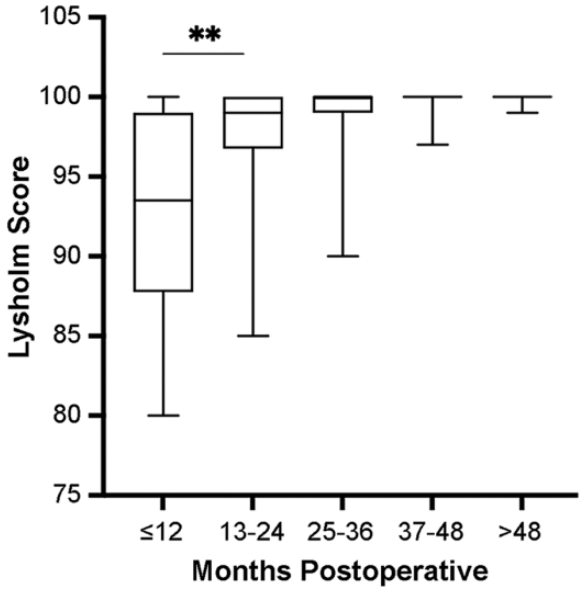

Figure 2. Comparison of postoperative clinical Lysholm scores for the different groups (months after the surgery). **Significant improvement between ≤12 months and 13-24 months postoperatively ($P < .01$, Kruskal-Wallis test).

Operative Technique

The ipsilateral proximal medial edge of the trochlea was used as the donor site for all patients in this study (Figure 1).

AOT instrumentation (Arthrex) was used for all cases. We took 1 or 2 cylindrical grafts from the superomedial margin (nonweightbearing area) of the medial femoral condyle of the ipsilateral knee. The depth of the graft varied from 10 to 15 mm, and the diameter was 8 mm; 1 or 2 osteochondral plugs were harvested. Backfilling of the defect was not necessary.

MRI Assessment

MRI of the knee joint was carried out on a 1.5-T clinical imaging system (United Imaging Healthcare), and T1-quick 3-dimensional sequences were used to evaluate articular cartilage morphology. Each of the explicit categories of the MOCART scores was recorded in all patients together with an overall score. Two musculoskeletal radiology specialists determined the MOCART 2.0 knee scores for all MRI findings of the donor sites in a blinded fashion.[22]

Statistical Analysis

All the continuous variables are described as means and standard deviations. The nonparametric Wilcoxon rank-sum test or Student t test was used to compare continuous variables, depending on the data distribution. The Fisher exact test was used to compare categorical variables. The Kruskal-Wallis test was used to compare the Lysholm scores of the time-based groups. The Spearman rank correlation was applied to evaluate the significance and strength of the relationship between independent variables such as patient age, number of grafts, BMI, Lysholm clinical outcomes, and MOCART scores. The alpha level was set at $<.05$. Statistical analyses were performed using Stata statistical software (Version 15; StataCorp).

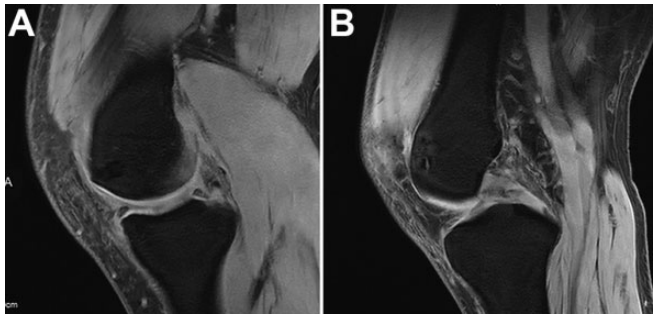

Figure 3. Sagittal T1-quick 3-dimensional knee magnetic resonance imaging was performed (A) 133 months after single-plug osteochondral autografting in a 29-year-old man, with the patient scoring 80 points on the MOCART scale at that time and (B) 106 months after double-plug osteochondral allografting in a 54-year-old man, with the patient scoring 70 points on the MOCART scale at that time. MOCART, magnetic resonance observation of repair tissue.

RESULTS

Outcome Measures

The mean follow-up time was 98.3 months (range, 67-144 months). For all 46 patients, the mean first-year follow-up Lysholm score was 92.5 ± 6.1 (range 80-100), and the final follow-up score was 99.9 ± 0.2 (range 99-100). The comparison of Lysholm scores grouped by 12-month postoperative intervals showed a significant improvement at the second year of follow-up ($P < .01$) (Figure 2). MRI of the donor sites was taken at an average of 93.8 ± 20.5 (range, 61-141) months postoperatively, and the mean MOCART score was 76.2 ± 4.9 (range 65-85).

There were 22 patients in the single-plug group, and 24 patients in the double-plug group. Representative postoperative MRI scans of a patient from each group are shown in Figure 3. The mean time until final follow-up MRI was 97.4 ± 24.7 months in the single-plug group and 90.5 ± 15.4 months in the double-plug group. As shown in Table 1, in terms of demographics, there was no significant difference between the single-plug and double-plug groups with respect to age, sex, follow-up period, mean final postoperative follow-up Lysholm scores, or MOCART scores.

Postoperative Complications

Two patients reported pain and swelling in the knee joint: 1 case in the single-plug group and 1 case in the double-plug group were identified. The patient in the single-plug group had mild pain when going up and down stairs and squatting, and the symptoms were slightly relieved at 6 months. The second patient had obvious discomfort when squatting,

TABLE 1
Clinical Outcomes of the Study Groups[a]

Parameter	Single Plug (n = 22)	Double Plug (n = 24)	*P*
Age, y	48.9 ± 15.3	50.2 ± 12.5	.76
Follow-up, months	101.7 ± 23.9	95.3 ± 15.0	.29
BMI	25.6 ± 3.11	25.6 ± 2.81	>.99
Sex			>.99
Male	13	14	
Female	9	10	
Final follow-up Lysholm score	100	99.9 ± 0.28	.16
MOCART score	76.4 ± 4.92	76.0 ± 5.10	.83

[a]Data are reported as mean ± SD or No. of patients. BMI, body mass index; MOCART, magnetic resonance observation of repair tissue.

TABLE 2
Correlation Between Demographics and the MOCART and Final Follow-up Lysholm Scores[a]

	MOCART		Lysholm	
Parameter	*r*	*P*	*r*	*P*
Age	−0.08	.60	−0.24	.11
BMI	−0.06	.68	0.06	.67
Number of grafts	−0.02	.87	−0.20	.17

[a]BMI, body mass index; MOCART, magnetic resonance observation of repair tissue.

and swelling occurred during heavy physical labor in the first year; the symptoms were resolved at 24 months. The overall incidence of DSM in this study was 4.3% at 1 year and 0% at the 24-month follow-up.

Prognostic Factors

Table 2 presents the correlation of patient characteristics with the MOCART and final follow-up Lysholm scores. No significant correlations were observed. In addition, there was no correlation between MOCART scores and final follow-up Lysholm scores (r = -0.06; P = .69).

DISCUSSION

The most important finding of this study was the low rate of morbidity of cartilage autograft transplants harvested from the proximal medial edge of the trochlea. The overall incidence of DSM in this study was 4.3% at 1 year and 0% at the 24-month follow-up. We also found no significant difference in clinical or radiological knee outcomes in patients undergoing single-plug and double-plug harvesting from the proximal medial edge of the trochlea. This is the first report on DSM in cartilage autograft transplants harvested from the proximal medial edge of the trochlea.

The most significant concern associated with AOT is DSM. Different donor sites, including the lateral femoral condyle,[2,3,21] medial femoral condyle,[14,28] notch of the trochlea,[23] lateral trochlear border,[13] lateral edge of the lateral trochlea,[12] and trochlear border,[9] have been reported.

The currently published rates of DSM after knee-to-talus autologous osteochondral transplantation procedures vary. Moreover, we found that the DSM rates varied with the time of publication. Gautier et al[9] reported 11 patients at a mean follow-up of 24 months, and 6 (54.5%) patients had DSM. Reddy et al[20] reported on 15 patients who underwent AOT with a mean follow-up of 47 months, and 4 patients (26.6%) had poor Lysholm criteria. Valderrabano et al[25] reported on 12 patients with a mean 72-month follow-up, and 6 patients (50%) had knee pain.

Since 2010, the published rates of DSM have decreased. Kim et al[12] reported 52 patients at a mean follow-up of 13.1 months, and there was no DSM. Woelfle et al[26] reported 32 patients (mean follow-up 29 months), and 2 patients (6%) had persisting postoperative knee pain. Haleem et al[10] reported 14 patients with a mean follow-up of 85 months, and 2 patients (4.8%) complained of knee donor-site stiffness, which resolved after 8 months. Flynn et al[5] reported 58 patients with a mean follow-up of 47.2 months, and 2 (2.4%) patients had DSM. Fraser et al[7] reported 39 patients with a mean follow-up of 41.8 months, and 5% of the patients had DSM at the final follow-up.

The difference in DSM might be associated with the location of the harvest site, and surgeons try to prevent this complication by, for example, employing mini-open arthrotomy and limiting the size and number of grafts. There are 2 reasons for choosing the proximal medial edge of the trochlea as the donor site. First, a biomechanical study showed that patellofemoral contact pressures are lowest along the medial trochlea, and osteochondral plugs from the medial femoral trochlea may be advisable.[8] Second, a biomechanical study showed that the patella had an orientation of lateral patellar shift at 90° tibiofemoral flexion.[4]

In the current study, the DSM symptoms of patients resolved over time, which is consistent with the findings of Fraser et al.[7] We infer that the donor site at the proximal medial trochlea may have less influence on the knee. With rehabilitation exercise, the symptoms will disappear naturally. The limited number of osteochondral grafts harvested from the knee (1 or 2 plugs) also reduced the risk of DSM.

Study findings also indicated that there was no significant difference in the clinical knee outcomes of patients based on the number of grafts harvested from the proximal medial edge of the trochlea, which is consistent with Paul et al.[19] The diagnostic value of MRI in AOT nevertheless remains unclear. We found that no correlation was observed between the MOCART score and Lysholm outcomes for the donor knee, which is consistent with Flynn et al.[7] It is conceivable that factors that are challenging to recognize on MRI scans (nerve growth, inflammation, and increased vascular penetration) can affect knee DSM.[16] Future studies trying to assess the clinical sensitivity of high-quality MRI scan evaluation techniques could be powerful.

Limitations

The shortcomings of this study are that it was retrospective and had a limited patient population. Of the 60 patients, 14

were lost to follow-up, and the study sample size may be correlated with DSM. Furthermore, we did not have radiographic images for a better look at possible pathological changes of the operated knee joint. Arthroscopy had not been performed on the donor sites. It may have been helpful to assess the arthroscopy results to identify pathological changes affecting DSM, especially in patients with symptoms. The scoring system had a prominent ceiling effect, and adaptive tests such as the Patient-Reported Outcomes Measurement Information System–Computer Adaptive Testing may be better at reducing ceiling and floor effects. Additional prospectively randomized and long-term studies on larger patient populations will need to be carried out to determine which donor sites are best for AOT as well as to calculate the exact risk of DSM.

CONCLUSION

AOT plays an essential role in the treatment of osteochondral lesions of the talus. Nevertheless, DSM and its potential influence on the functional status of the patient have always been concerns with this procedure. In this study, the donor autografts were harvested from the proximal medial edge of the trochlea. The overall incidence of DSM was only 4.3% at 1 year and decreased to 0% at the 2-year follow-up. The clinical and radiological outcomes of patients were not affected by the number of grafts harvested from the proximal medial edge of the trochlea.

ACKNOWLEDGMENT

The authors gratefully thank Kaizhe Chen, Minglong Qiu, Haoyi Chen, and Zhijie Chen for collecting information during this study. They also thank the study patients, whose participation made this research possible.

REFERENCES

1. Ahmad CS, Cohen ZA, Levine WN, Ateshian GA, Mow VC. Biomechanical and topographic considerations for autologous osteochondral grafting in the knee. *Am J Sports Med*. 2001;29(2):201-206.
2. Al-Shaikh RA, Chou LB, Mann JA, Dreeben SM, Prieskorn D. Autologous osteochondral grafting for talar cartilage defects. *Foot Ankle Int*. 2002; 23(5):381-389.
3. Baltzer AW, Arnold JP. Bone-cartilage transplantation from the ipsilateral knee for chondral lesions of the talus. *Arthroscopy*. 2005;21(2):159-166.
4. Brunet ME, Brinker MR, Cook SD, et al. Patellar tracking during simulated quadriceps contraction. *Clin Orthop Relat Res*. 2003;414:266-275.
5. Flynn S, Ross KA, Hannon CP, et al. Autologous osteochondral transplantation for osteochondral lesions of the talus. *Foot Ankle Int*. 2016; 37(4):363-372.
6. Fraser EJ, Harris MC, Prado MP, Kennedy JG. Autologous osteochondral transplantation for osteochondral lesions of the talus in an athletic population. *Knee Surg Sports Traumatol Arthrosc*. 2016;24(4): 1272-1279.
7. Fraser EJ, Savage-Elliott I, Yasui Y, et al. Clinical and MRI donor site outcomes following autologous osteochondral transplantation for talar osteochondral lesions. *Foot Ankle Int*. 2016;37(9):968-976.
8. Garretson RB III, Katolik LI, Verma N, et al. Contact pressure at osteochondral donor sites in the patellofemoral joint. *Am J Sports Med*. 2004;32(4):967-974.
9. Gautier E, Kolker D, Jakob RP. Treatment of cartilage defects of the talus by autologous osteochondral grafts. *J Bone Joint Surg Br*. 2002; 84(2):237-244.
10. Haleem AM, Ross KA, Smyth NA, et al. Double-plug autologous osteochondral transplantation shows equal functional outcomes compared with single-plug procedures in lesions of the talar dome: a minimum 5-year clinical follow-up. *Am J Sports Med*. 2014;42(8):1888-1895.
11. Hurley ET, Murawski CD, Paul J, et al. Osteochondral autograft: proceedings of the international consensus meeting on cartilage repair of the ankle. *Foot Ankle Int*. 2018;39(1)(suppl):28S-34S.
12. Kim YS, Park EH, Kim YC, Koh YG, Lee JW. Factors associated with the clinical outcomes of the osteochondral autograft transfer system in osteochondral lesions of the talus: second-look arthroscopic evaluation. *Am J Sports Med*. 2012;40(12):2709-2719.
13. Largey A, Faure P, Hebrard W, Hamoui M, Canovas F. Osteochondral transfer using a transmalleolar approach for arthroscopic management of talus posteromedial lesions. *Orthop Traumatol Surg Res*. 2009;95(7):537-542.
14. Lee CH, Chao KH, Huang GS, Wu SS. Osteochondral autografts for osteochondritis dissecans of the talus. *Foot Ankle Int*. 2003;24(11): 815-822.
15. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med*. 1982; 10(3):150-154.
16. Mapp PI, Walsh DA. Mechanisms and targets of angiogenesis and nerve growth in osteoarthritis. *Nat Rev Rheumatol*. 2012;8(7):390-398.
17. Murawski CD, Kennedy JG. Operative treatment of osteochondral lesions of the talus. *J Bone Joint Surg Am*. 2013;95(11):1045-1054.
18. Nguyen A, Ramasamy A, Walsh M, McMenemy L, Calder JDF. Autologous osteochondral transplantation for large osteochondral lesions of the talus is a viable option in an athletic population. *Am J Sports Med*. 2019;47(14):3429-3435.
19. Paul J, Sagstetter A, Kriner M, et al. Donor-site morbidity after osteochondral autologous transplantation for lesions of the talus. *J Bone Joint Surg Am*. 2009;91(7):1683-1688.
20. Reddy S, Pedowitz DI, Parekh SG, Sennett BJ, Okereke E. The morbidity associated with osteochondral harvest from asymptomatic knees for the treatment of osteochondral lesions of the talus. *Am J Sports Med*. 2007;35(1):80-85.
21. Ross AW, Murawski CD, Fraser EJ, et al. Autologous osteochondral transplantation for osteochondral lesions of the talus: does previous bone marrow stimulation negatively affect clinical outcome? *Arthroscopy*. 2016;32(7):1377-1383.
22. Schreiner MM, Raudner M, Marlovits S, et al. The MOCART (Magnetic Resonance Observation of Cartilage Repair Tissue) 2.0 Knee Score and Atlas. *Cartilage*. 2021;13(1)(suppl):571S-587S.
23. Scranton PE Jr, Frey CC, Feder KS. Outcome of osteochondral autograft transplantation for type-V cystic osteochondral lesions of the talus. *J Bone Joint Surg Br*. 2006;88(5):614-619.
24. Shimozono Y, Seow D, Yasui Y, Fields K, Kennedy JG. Knee-to-talus donor-site morbidity following autologous osteochondral transplantation: a meta-analysis with best-case and worst-case analysis. *Clin Orthop Relat Res*. 2019;477(8):1915-1931.
25. Valderrabano V, Leumann A, Rasch H, et al. Knee-to-ankle mosaicplasty for the treatment of osteochondral lesions of the ankle joint. *Am J Sports Med*. 2009;37(suppl 1):105S-111S.
26. Woelfle JV, Reichel H, Javaheripour-Otto K, Nelitz M. Clinical outcome and magnetic resonance imaging after osteochondral autologous transplantation in osteochondritis dissecans of the talus. *Foot Ankle Int*. 2013;34(2):173-179.
27. Yoon HS, Park YJ, Lee M, Choi WJ, Lee JW. Osteochondral autologous transplantation is superior to repeat arthroscopy for the treatment of osteochondral lesions of the talus after failed primary arthroscopic treatment. *Am J Sports Med*. 2014;42(8):1896-1903.
28. Zhu Y, Xu X. Osteochondral autograft transfer combined with cancellous allografts for large cystic osteochondral defect of the talus. *Foot Ankle Int*. 2016;37(10):1113-1118.