


EXTENSOR MECHANISM TRANSPLANTATION AFTER KNEE PROSTHESIS: 70-MONTH FOLLOW-UP

TRANSPLANTE DE MECANISMO EXTENSOR APÓS PRÓTESE DE JOELHO: SEGUIMENTO 70 MESES

CAMILO PARTEZANI HELITO¹ , ALAN DE PAULA MOZELLA² , BRUNO BUTTURI VARONE¹ , MARCO KAWAMURA DEMANGE¹ , RICCARDO GOMES GOBBI¹ , SANDRA TIE NISHIBE MINAMOTO² , HUGO ALEXANDRE DE ARAUJO BARROS COBRA² 

1. Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology, Department of Orthopedics and Traumatology, Knee Group, HC-DOT/FMUSP, São Paulo, SP, Brazil.

2. Instituto Nacional de Traumatologia e Ortopedia, São Paulo, SP, Brazil.

ABSTRACT

Objective: This article reports the range of motion, failure rate, and complications of patients with extensor mechanism injury after total knee arthroplasty (TKA) treated with extensor mechanism allograft with mid-term follow-up. **Methods:** Patients undergoing post-ATJ extensor mechanism transplantation from 2009 to 2018 were retrospectively evaluated. Demographics, the reason for transplantation, elapsed time from arthroplasty to transplantation, related surgical factors, immobilization time, range of motion, transplant failure, and complications were collected. The minimum follow-up was 24 months. **Results:** Twenty patients were evaluated. The mean follow-up was 70.8 +/- 33.6 months. The most common cause of extensor mechanism rupture was traumatic in 10 (50%) cases. Six patients underwent associated surgeries, one case of medial ligament complex reconstruction, and 5 cases of TKA revision. Eleven patients (55%) had transplant-related complications. The most common complication was an infection. Five cases presented transplant failure. **Conclusion:** Patients who underwent extensor mechanism allograft transplantation after total knee arthroplasty had a 25% failure rate with a mean follow-up of 6 years. Although there was no loss of flexion with the procedure and prolonged immobilization, the complication rate was not low. **Level of evidence IV; case series.**

Keywords: Knee Arthroplasty. Partial Knee Replacement. Knee Replacement Arthroplasties.

RESUMO

Objetivo: O objetivo do estudo foi relatar amplitude de movimento, taxa de falha e complicações de pacientes com lesão do mecanismo extensor após artroplastia total do joelho (ATJ) tratados com aloenxerto do mecanismo extensor com acompanhamento no médio prazo. **Métodos:** Pacientes submetidos a transplante de mecanismo extensor pós-ATJ de 2009 a 2018 foram avaliados retrospectivamente. Foram avaliados dados demográficos, motivo do transplante, tempo decorrido da artroplastia ao transplante, fatores cirúrgicos relacionados, tempo de imobilização, arco de movimento, falha do transplante e complicações. O acompanhamento mínimo foi de 24 meses. **Resultados:** Vinte pacientes foram avaliados. O tempo médio de acompanhamento foi de 70,8 +/- 33,6 meses. A causa mais comum de ruptura do mecanismo extensor foi traumática em 10 (50%) casos. Seis pacientes foram submetidos a cirurgias associadas, um caso de reconstrução do complexo ligamentar medial e 5 casos de revisão de ATJ. Onze pacientes (55%) tiveram complicações relacionadas ao transplante. A complicação mais comum foi a infecção. Cinco casos apresentaram falha do transplante. **Conclusão:** Pacientes submetidos a transplante de aloenxerto de mecanismo extensor após artroplastia total de joelho apresentam taxa de falha de 25% com seguimento médio de 6 anos. Embora não tenha havido perda de flexão com o procedimento e com a imobilização prolongada, o índice de complicações não foi baixo. **Nível de evidência IV; série de casos.**

Descritores: Artroplastia do Joelho. Substituição Parcial do Joelho. Artroplastia de Substituição do Joelho.

Citation: Helito CP, Mozella AP, Varone BB, Demange MK, Gobbi RG, Minamoto STN, Cobra HAAB. Extensor mechanism transplantation after knee prosthesis: 70-month follow-up. Acta Ortop Bras. [online]. 2022;30(1)Esp.: Page 1 of 5. Available from URL: <http://www.scielo.br/aob>.

INTRODUCTION

Despite the satisfactory results presented by patients undergoing total knee arthroplasty (TKA), the incidence of postoperative complications is not negligible.^{1,2} In absolute numbers, estimates point to the occurrence of a greater number of complications due to the increase in the number of surgeries performed annually.³

Among the complications, rupture of the knee extensor mechanism, despite the low incidence, occurring between 0.1% and 2.5% of all TKAs, represents a serious and difficult to manage complication, often evolving with limited clinical results, a high number of reoperations and a high failure rate in patient follow-up.^{4,5}

All authors declare no potential conflict of interest related to this article.

The study was conducted at Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology, Department of Orthopedics and Traumatology, Knee Group, HC-DOT/FMUSP, Sao Paulo, SP, Brazil and Instituto Nacional de Traumatologia e Ortopedia, Sao Paulo, SP, Brazil. Correspondence: Bruno Butturi Varone. Rua Arruda Alvim 145 ap 34, São Paulo, Brazil. 05410-020. brunobutturivarone@yahoo.com.br

Article received on 06/18/2021, approved in 09/16/2021.



Lesions of the extensor mechanism after TKA show inferior results than those reported for the surgical treatment of these injuries in patients without arthroplasty.⁶ In a study evaluating the treatment of patellar tendon injury, Fiquet et al.⁶ found 33% of allograft treatment failure in patients with TKA and no failure when the same surgical technique was applied in patients without a prosthesis. Also, direct repair of an extensor mechanism lesion in patients with an arthroplasty showed poor results, especially when the injury occurred in the patellar tendon.⁷ Thus, alternatives for surgical treatment should be evaluated.

Currently, the two most widely used surgical treatment options for injuries of the extensor mechanism after arthroplasty are allograft reconstruction and reconstruction with synthetic mesh.^{8,9} A systematic review by Chau et al. found a failure rate of approximately 25% in both methods.¹⁰ Survival rates were also similar for the two techniques in a meta-analysis performed by Deren et al.⁸ However, most of the studies included in these reviews had a follow-up of fewer than 5 years (only Ricciardi et al.¹¹ reported a follow-up of more than 5 years for the allograft technique) and a reduced number of studied knees (only Ricciardi et al., Brown et al. and Diaz-Ledezma et al., who used an Achilles tendon, presented series with more than 20 knees using allografts).¹¹⁻¹³

Thus, this present study aims to report the range of motion, failure rate and complications of patients with extensor mechanism injury after TKA treated with extensor mechanism allograft with a medium-term follow-up. As a hypothesis, we assume the failure rate will be similar to the literature in short-term follow up studies since we believe that the initial complications are the most significant for graft survival.

METHODS

Patients who underwent post-TKA extensor mechanism transplantation from 2009 to 2018 in two high-volume services for the treatment of post-TKA complications (blinded for review purposes) were retrospectively evaluated with prospective data collection. Only patients with allograft composed of quadriceps tendon, patella, patellar tendon, and tibial tuberosity were included. (Figure 1) The grafts were previously-stored frozen at -80°C and not irradiated. Any procedure with an extensor mechanism graft without this configuration or reconstructions with Achilles tendon, possible other tendons or reconstruction with synthetic material, even if associated with allograft, were not included. Patients with primary or revision arthroplasty were included. Only patients with 24 or

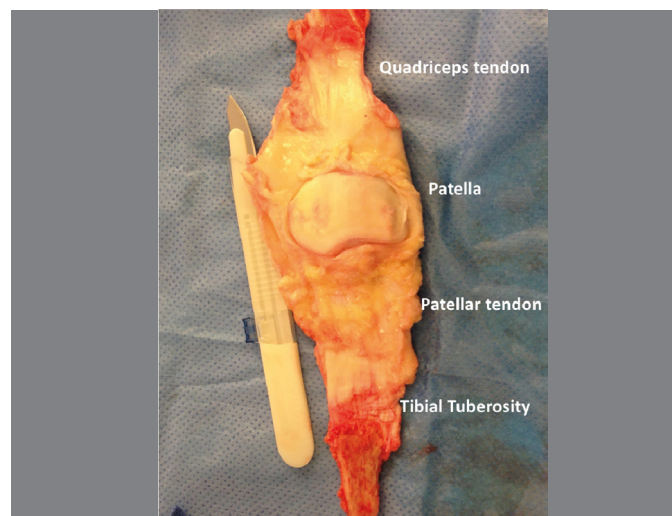


Figure 1. Extensor mechanism allograft.

more months of follow-up were included. Patients who died were not excluded, and the last assessment before death was used for data collection purposes.

Demographic data of the patients were evaluated, including age, gender, comorbidities, and ASA classification, the reason for the transplantation of the extensor mechanism, time from arthroplasty to transplantation, surgical factors as the technique used, combined surgeries with the transplantation or post-transplant, replacement of the patella at the time of transplantation, immobilization time, range of motion before and after transplantation, the eventual failure of the transplant and associated complications.

Transplant failure was considered as the need to remove the transplant for any reason or limitation of active knee extension greater than 30 degrees. Patients who presented with knee flexion restriction after transplantation were not considered as failure.

The data will be presented as mean and standard deviation for nominal variables and absolute numbers and percentages for categorical variables. Statistical analysis was performed to assess the range of motion pre- and postoperatively with the Mann-Whitney test. Institute of Orthopedics and Traumatology, Hospital das Clínicas, Faculty of Medicine, University of São Paulo (IOT-HC-FMUSP) with approval by the Ethics Committee.

RESULTS

Twenty patients who underwent transplantation of the knee extensor mechanism were evaluated according to the established criteria. The mean age of the patients was 68.6 +/- 14.3 years, 14 of which were female and 6 male and 8 on the left side and 12 on the right side. Fourteen patients had at least one clinical comorbidity of which 35% had diabetes, 35% were obese, 10% were smokers, and 5% presented inflammatory disease (rheumatoid arthritis). The vast majority of patients (90%) were classified as ASA 2 at the time of transplantation, with only 1 patient being classified as ASA 1 and one as ASA 3. The mean follow-up time was 70.8 +/- 33.6 months. The average time between arthroplasty and transplantation was 47.6 +/- 30 months, with 16 patients having primary implants and 4 patients revision implants (two semi-constrained, and two hinge). Joint replacement before rupture of the extensor mechanism was performed by medial parapatellar access in all cases and in only one patient a lateral release was performed. In 15 patients, the patella had been replaced during the arthroplasty. The most common cause of rupture of the extensor mechanism was traumatic due to falling from height in 10 (50%) cases, followed by iatrogenic in 4 cases, one case due to closed manipulation for stiffness after primary TKA, and 3 due to intraoperative injury in additional surgeries after arthroplasty. The causes of injury are described in (Table 1). Regarding the surgical technique, 17 cases were operated with fixation of the tibial tuberosity bone block with the press-fit technique associated with screws, one case with screws only, one case with the press-fit technique associated with wires and screws and a case with press-fit technique associated with wires only, without using screws. (Figure 2) At the time of the transplant, six patients underwent associated surgeries, one case of associated reconstruction of the medial ligament complex, and 5 cases of TKA revision. The patellar component was implanted in the allograft in 14 cases and the patella was kept native in 6 cases. (Figure 3) The post-transplant immobilization time was 6.5 +/- 0.9 weeks, ranging from 6 to 8 weeks. Regarding the range of motion, the average preoperative extension deficit was 70.2 +/- 22.3 degrees, with 10 patients having a complete extension disability. The average postoperative deficit was 10.5 +/- 22.0 degrees, with 10 patients not having any deficit in postoperative active extension. Regarding flexion, the preoperative average was 100.5 +/- 19.3 degrees and the postoperative was 99.2 +/- 14.1 degrees. The extension deficit showed statistical

Table 1. Demographic data of patients subjected to extensor mechanism allograft after total knee arthroplasty.

Age (years)	68.6 +/- 14.3
Gender	Female 14
	Male 6
Side	Left side 8
	Right side 12
Presence of Comorbidities	14 (70%)
ASA classification	ASA 1 – 1 (5%)
	ASA 2 – 18 (90%)
	ASA 3 – 1 (5%)
Type of Arthroplasty	Primary 16 (80%)
	Semi-constrained 2 (10%)
	Hinge 2 (10%)
Average time between arthroplasty and transplantation (months)	47.6 +/- 30.0
Cause of injury to the extensor mechanism	Traumatic (fall) 10
	Iatrogenic 4
	Patellofemoral disorders 3
	Infection 1
	Tumor resection 1
	Patellar necrosis 1
Follow-up time (months)	70.8 +/- 33.6
Surgical technique for the extensor mechanism allograft tibial fixation	Press-fit + screw 17
	Screw only 1
	Press-fit + screw + wires 1
	Press-fit + wires 1
Associated procedures	5 TKA revision
	1 medial ligament complex reconstruction
Patellar resurface in allograft	14 (70%)
Immobilization time (weeks)	6.5 +/- 0.9



Figure 2. Fixation of the tibial tuberosity bone block with the press-fit technique associated with screws.

improvement between the pre and postoperative periods and the maximum flexion remained similar. (Table 2)

Eleven patients (55%) had complications related to transplantation and required 22 new surgical procedures (average of 2 per patient). The most common complication was infection, being superficial treated only with antibiotics in two cases, and deep requiring surgical procedures in three cases. Five cases also presented transplant

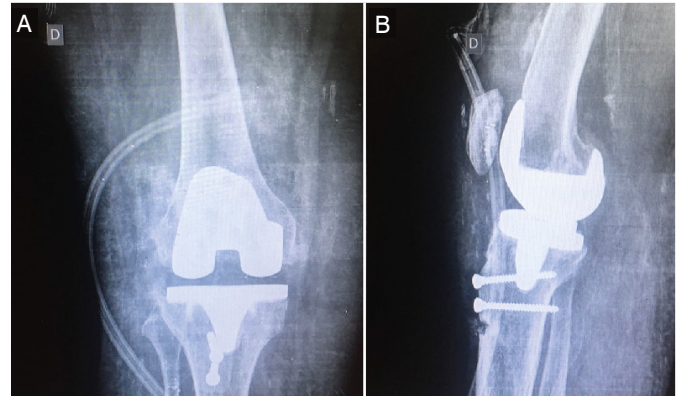


Figure 3. Post-operative X-rays.

Table 2. Pre- and post-operative range of motion of patients subjected to extensor mechanism allograft transplantation after total knee arthroplasty.

Pre-operative Extension deficit	Post-operative Extension deficit	p	Pre-operative maximum flexion	Post-op maximum flexion	p
70.2 +/- 22.3	10.5 +/- 22.0	<0.00001	100.5 +/- 19.3	99.2 +/- 14.1	0.589

failure, with 3 cases of persistent extension deficit, one case of infection with skin and allograft necrosis, and one case of late patella fracture with osteosynthesis failure and transplant loss. In 3 cases, despite the incorporation of the transplant, the patients' maximum flexion was below 90 degrees. Two failed patients underwent a successful post-failure transplant review.

DISCUSSION

The main finding of this study is that the survival rate of the allograft of the extensor mechanism with an average follow-up of 6 years was 75% and there was no loss of flexion compared to the preoperative period, but the rate of complications and re-operations was not low. The rupture of the extensor mechanism after primary or revision arthroplasty, although rare, represents a serious complication associated with a high number of reoperations, as shown in our study, and with limited postoperative functional results.^{14,15} Thus, despite the existence of several techniques to treat this complication, the controversy persists whether the transplantation of the extensor mechanism presents superior results for the treatment of these lesions.⁸

The initial results of transplanting the extensor mechanism in patients with knee joint prostheses was limited; however, graft fixation was performed with 60 degrees of flexion, which was later related to this high failure rate.^{4,16,17} The tension of the graft in full extension was initially described by Nazarim and Booth, who had a higher success rate.¹⁵ Similar results were also observed by Brown et al, Diaz-Ledeza et al, who used Achilles tendon allografts, and Courtney et al, who reported success in 62%, 58.6%, and 55.8%, respectively.^{7,12,13} In our study, we were successful in transplanting the extensor mechanism in 75% of cases, numbers that agree with those presented by Deren et al. in a recent meta-analysis, showing a 72.8% rate of treatment success with allograft and 78% with synthetic mesh.⁸ In addition to tensioning in extension, the immobilization time must be at least 6 weeks. Even with the prolonged immobilization time, there was no loss of flexion compared to the preoperative period after rehabilitation.

In our study, half of the patients did not have a deficit in knee extension, with an average limitation of 10 degrees. Our results are in line with the study by Shau et al.¹⁰ who demonstrated an average extension deficit of 7.7 degrees and without repercussions

on maximum flexion. However, worse knee extension capacity was reported by Wood et al. with an average deficit of 26 degrees.¹⁸ We believed that such functional limitation can be attributed, at least partially, to the fact that the authors used Achilles tendon grafts in 43% of these patients and, mainly, to the fact that 86% of the grafts were irradiated. The graft irradiation can compromise the structural integration, as admitted by the authors and, thus, we understand that there may be impairment in the functional result and alteration of the graft incorporation capacity, in addition to the possibility of progressive loss of graft tension and consequent stretching with time.^{18,19}

In the study by Ricciardi et al., in medium-term follow-up, the success rate and retention of transplants of the extensor mechanism was 69%, however, the authors highlighted the high number of complications and reoperations, so that the reoperation-free survival was only 42%, similar to our study which was 45%.¹¹ These authors also demonstrated that patients with less age or those who underwent a concomitant revision surgery at the time of transplantation were associated with a higher rate of graft failure. Ricciardi et al. demonstrated that several reoperations were performed on transplant patients, however without progression to graft failure.¹¹ Complications related to fixation of the transplanted graft were also observed in the study by Brown et al., mainly in the tibia.¹³ In our series, we observed only one complication not directly related to the fixation of the transplanted graft, in which there was a peri-prosthetic fracture in an area of weakness between the bone block and tunnels used to perform a medial complex reconstruction. Possibly we had few complications related to fixation due to the care given in preparing the tibial bone block to be transplanted, as well as careful preparation of the receiving tibial bed, avoiding the exaggerated weakening of the tibial cortices and also the adherence to a conservative rehabilitation protocol.

At the beginning of the study, we believed that the initial complications are the most significant for graft survival. Burnett et al. demonstrated an initial failure rate of 23% in 13 transplant patients followed for 3 years.¹⁴ In a subsequent study, the same authors published a series of 47 patients who underwent 50 transplants under long-term follow-up and found graft failure, on average after 21 months, in 38% of cases, with a graft survival of 56% in 10 years. Similarly, the 10-year graft survival in the series by Brown

et al. was 56.2%.¹³ According to these authors, 38% (19 knees) of the transplants evolved with failure criteria on average 21 months after the reconstruction without it being possible to identify risk factors for failure or complications after the transplant. Contrary to our initial understanding, Brown et al. report the degradation of results over time due to the high rate of complications, leading to a 10-year survival of just over half of the grafts.¹³ We emphasize, however, that the criteria used in the definition of graft failure were more rigorous than most series.

In the study by Ricciardi et al. infection was the main cause of transplant failure, accounting for 50% of cases.¹¹ The rupture of the patellar tendon accounted for another 25% of the failures. In our study, most of the failures were due to the non-incorporation of the graft and lag of extension greater than 30 degrees. Only one case had an infection as the cause of failure, although 25% of cases had some type of infection after transplantation. Infection after transplantation of the extensor mechanism is a concern in the scenario of patients with a complex medical history and frequently undergoing several previous joint surgeries, however, Deren et al. demonstrated a relative risk of infection similar to patients undergoing reconstruction of the extensor mechanism with synthetic material.⁸ Similarly, the number of revisions for any reason was also indistinct between the two techniques (14.2% for transplant versus 16% for synthetic reconstructions).

This study is not without limitations. Although it was performed in two reference institutions with a high volume of knee arthroplasties, only 20 cases of transplantation of the extensor mechanism were identified in 10 years, corroborating the rarity of this complication. Also, the technique performed was not exactly the same in all cases, as well as the time the patients were kept immobilized. In any case, few series with this amount of cases and exclusively using a complete extensor mechanism allograft have a medium follow-up and the reported findings are of significant importance.

CONCLUSION

Patients undergoing extensor mechanism allograft transplantation after total knee arthroplasty have a failure rate of 25% with an average follow-up of 6 years. Although there was no loss of flexion with the procedure and prolonged immobilization, the rate of complications was not low.

AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of this article. CPH: substantial contributions to the conception and design of the manuscript and performed the surgeries. APM: background theory and performed the surgeries. BBV: editing and submitting. MKD: revising the text and performed the surgeries. RGG: Revising the figures, and performed the surgeries. STNM: data analysis and interpretation. HAABC: writing of the article and performed the surgeries.

REFERENCES

1. Bovonratwet, P. et al. Reasons and Risk Factors for 30-Day Readmission After Outpatient Total Knee Arthroplasty: A Review of 3015 Cases. *J Arthroplasty*; 2020; 35(9): p. 2451-2457.
2. Lan RH, Y.J., Samuel LT, Pappas MA, Brooks PJ, Kamath AF. How are We Measuring Cost-Effectiveness in Total Joint Arthroplasty Studies? Systematic Review of the Literature. *The Journal of Arthroplasty*. 2020
3. Kurtz, S., et al. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am*. 2007; 89(4): p. 780-5.
4. Maffulli, N., et al. The Management of Extensor Mechanism Disruption After Total Knee Arthroplasty: A Systematic Review. *Sports Med Arthrosc Rev*. 2017; 25(1): p. 41-50.
5. Vajapey, S.P., et al. Treatment of Extensor Tendon Disruption After Total Knee Arthroplasty: A Systematic Review. *J Arthroplasty*. 2019; 34(6): p. 1279-1286.
6. Fiquet, C., et al. Partial extensor mechanism allograft reconstruction for chronic patellar tendon disruption shows superior outcomes in native knees when compared to the same technique following total arthroplasty. *Int. Orthop*. 2018; 42(11): p. 2591-2599.
7. Courtney PM, E.T., Pflederer CT, Levine BR, Gerlinger T. Is There Any Role for Direct Repair of Extensor Mechanism Disruption Following Total Knee Arthroplasty? *The Journal of Arthroplasty*. 2017
8. Deren, M.E., et al. Meta-analysis Comparing Allograft to Synthetic Reconstruction for Extensor Mechanism Disruption after Total Knee Arthroplasty. *J Knee Surg*. 2019
9. Buller LT, W.L., Deckard ER, Meneghini RM. Extensor Mechanism Reconstruction Using Marlex Mesh, is Postoperative Casting Mandatory? *The Journal of Arthroplasty*. 2020
10. Shau, D., et al. Synthetic mesh vs. allograft extensor mechanism reconstruction in total knee arthroplasty - A systematic review of the literature and meta-analysis. *Knee*. 2018; 25(1): p. 2-7.
11. Ricciardi, B.F., et al. Survivorship of Extensor Mechanism Allograft Reconstruction After Total Knee Arthroplasty. *J Arthroplasty*. 2017; 32(1): p. 183-188.
12. Diaz-Ledezma, C., et al. Extensor mechanism reconstruction with Achilles tendon allograft in TKA: results of an abbreviated rehabilitation protocol. *J Arthroplasty*. 2014; 29(6): p. 1211-5.

-
13. Brown, N.M., et al. Extensor mechanism allograft reconstruction for extensor mechanism failure following total knee arthroplasty. *J Bone Joint Surg Am.* 2015; 97(4): p. 279-83.
 14. Burnett, R.S., R.A. Butler, and R.L. Barrack. Extensor mechanism allograft reconstruction in TKA at a mean of 56 months. *Clin Orthop Relat Res.* 2006; 452: p. 159-65.
 15. Nazarian, D.G. and R.E. Booth, Jr. Extensor mechanism allografts in total knee arthroplasty. *Clin Orthop Relat Res.* 1999; (367): p. 123-9.
 16. Leopold, S.S., et al. High rate of failure of allograft reconstruction of the extensor mechanism after total knee arthroplasty. *J Bone Joint Surg Am.* 1999; 81(11): p. 1574-9.
 17. Burnett, R.S., et al. Extensor mechanism allograft reconstruction after total knee arthroplasty. A comparison of two techniques. *J Bone Joint Surg Am.* 2004; 86(12): p. 2694-9.
 18. Wood, T.J., et al. Synthetic Graft Compared With Allograft Reconstruction for Extensor Mechanism Disruption in Total Knee Arthroplasty: A Multicenter Cohort Study. *J Am Acad Orthop Surg.* 2019; 27(12): p. 451-457.
 19. Wang, S., et al. Autograft or Allograft? Irradiated or Not? A Contrast Between Autograft and Allograft in Anterior Cruciate Ligament Reconstruction: A Meta-analysis. *Arthroscopy.* 2018; 34(12): p. 3258-3265.