RESEARCH ARTICLE

Return to Sport and Re-Injury Rate after Double-Bundle Anterior Cruciate Ligament Reconstruction with at least Five Years of Follow-Up

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Abstract

Background: This study retrospectively evaluated the medium- and long-term results of patients submitted to double-bundle (DB) anterior cruciate ligament (ACL) reconstruction.

Methods: A retrospective study of case series at a single center. Cases submitted to isolated ACL reconstruction with at least five years of follow-up were included. The following data were collected: demographic data; practice of competitive sport before the injury; previous surgery; injury/surgery in the contralateral knee; return to the practices of sports and level; re-injury (postoperative time; mechanism; need for surgery); and symptoms at the last clinical follow-up visit. Descriptive and sub-group analyses were performed.

Results: Sixty-nine patients were included; 52 men (75%), 49 athletes (71%), 47 (68%) with primary injury, mean age of 30 years (SD 10). The patients were followed up for an average of 8.7 years (minimum 5, maximum 11.8) after surgery. After the reconstruction, 67 (97%) returned to the sport; 75% at the same level as before the injury. Ten patients (14%) suffered re-injury after an average of 32 months (between 9 and 50 months). Regarding the outcome of re-injury, no statistically significant differences were found between subgroups of athletes vs non-athletes or primary injury vs revision surgery, despite a significant tendency towards increased re-injury levels in athletes. However, this tendency was not statistically significant.

Conclusion: In our series of patients operated on with the double-bundle technique and with a long follow-up time, 14% presented re-injury, with no differences between primary and revision cases, and with a trend towards higher re-injury levels among the athletes in relation to the non-athletes. The rate of return to sport was satisfactory, with 97%, of which 75% were playing at the same level as before the injury.

Level of evidence: IV

Keywords: Knee, Sport, Anterior Cruciate Ligament, Arthroscopy

Introduction

Anterior cruciate ligament injury affects knee stability and may be the cause of secondary injuries such as meniscal tears and osteoarthrosis (1). This injury mainly affects young people and athletes; 70% of these injuries occur during physical activity, and it is estimated that anterior cruciate ligament (ACL) injury accounts for 50% of all ligament injuries of the knee. This problem leads to the athlete having to stop playing sports, functional limitation for daily activities, and later development of osteoarthrosis (2).

The ACL plays an important role in stabilizing anterior and rotational translation of the tibia in relation to the femur. Anatomical and biomechanical studies have demonstrated that the ligament consists of two bundles; the anteromedial (AM) and the posterolateral (PL). The AM controls anterior translation, while the PL controls rotation (3).

Single-bundle reconstruction (SB) prioritizes reconstruction of the isolated anteromedial bundle or a single bundle fixed to the femur between the anatomical positions of the two bundles. Double-bundle (DB)

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reconstruction is an anatomical reconstruction aimed at increasing rotational stability, as demonstrated by biomechanical studies (4,5).

The literature presents many comparative and review studies comparing the techniques, often with controversial results. The majority of biomechanical studies, in vivo and some clinical controlled studies have already pointed out that patients treated with the DB technique have better knee stability, but most obtained equivalent functional results to patients treated with SB (6,7). One exception was the study of Zaffagnini et al. in 2011 and Jarvela et al. (2017), which demonstrated lower rates of re-intervention and better clinical results in the DB group (8,9). A meta-analysis of 2017 evaluated 26 randomized prospective studies and demonstrated better results in patients submitted to DB reconstruction, in terms of both stability and functional outcomes (10).

Although some studies have not yet demonstrated clinical superiority, most have conducted evaluations with short or medium follow-up times (less than five years) and few studies have evaluated parameters such as graft failure, osteoarthrosis and return to sports activities (11,12). In 2019, a meta-analysis of only randomized clinical studies with more than five years of follow-up was not able to demonstrate any difference between single- and double-bundle ACL reconstruction in terms of clinical scores, clinical stability and osteoarthrosis (13). However, evaluating randomized comparative studies with more than five years of follow-up in relation to re-injury rate, the studies of Jarvela and Suomalainen showed better results in the double-bundle group, as did a Swedish study by Svanesson et al., with 22,640 patients (14,15). However, a recent study by Mayr et al. did not demonstrate any clinical differences or any case of re-injury in at least five years of follow-up, and a randomized clinical trial conducted in 2019 did not demonstrate any clinical differences and/or re-injuries (16,17). These studies with longer follow-up times generally do not compare rates of return to sport, and most of them do not include a significant sample of athletes.

We have performed the double-bundle technique since 2006, though not exclusively. This is a research line of our group, and a larger cohort study is currently underway to compare techniques retrospectively in athletes. D'Elia et al. performed a comparative study of rotation in our movement analysis laboratory, and despite a tendency towards better rotational control in patients submitted to double-bundle reconstruction, the results were not statistically significant (18,19).

The objective of this retrospective study is to evaluate the rate of return to sport and re-injury in patients submitted to anterior cruciate ligament reconstruction using DB with at least five years of follow-up.

Materials and Methods

This study was approved by the Research Ethics Committee. Data from patient records submitted to ACL reconstruction at Instituto Vita between December 2006 and November 2014 using the double-bundle technique were investigated. During this period, we performed 140 reconstructions with the double-bundle technique, including both primary and revision cases. The inclusion criteria were: patients submitted to isolated ACL reconstruction with the double-bundle technique and at least five years of follow-up, whether primary or revision; whether or not they practiced recreational or competitive sports; and both sexes. The exclusion criteria were: reconstructions associated with osteotomies (tibial or femoral), meniscus repair, total or subtotal meniscectomy, cartilage transplants, femoral patellar ligament reconstructions, medial collateral, posterior cruciate, posterolateral corner or anterolateral ligament of the affected knees; and patients with incomplete medical records.

The following data were gathered from the medical records: practice of competitive sport before the injury; previous surgery; injury/surgery to the contralateral knee, and symptoms during follow-up. The patients were contacted and asked about the following parameters: re-injury (postoperative time; mechanism; need for surgery), return to sport and if so, at what level. The data were then submitted to descriptive analysis. Continuous data comparisons were made by the Student's t test or Mann-Whitney test for independent samples, according to whether or not the data followed normal distribution. Qualitative data comparisons were made by the chi-square test (or the Monte Carlo method if the percentages were lower than 5%). To study survival, Kaplan-Meier survival curves were obtained, and differences were searched using log-rank test. The level of significance adopted was 95%, and the tests were performed using the software program SPSS.

The technique used was always the same, and was conducted by four surgeons of the group. [Figure 1] represents the surgical procedure. ACL reconstruction with double bundle was performed using autologous grafts from the semitendinosus and gracilis tendon (STG), but fixed in two tibial tunnels and two femoral tunnels. After obtaining the graft, the arthroscopy-assisted ACL reconstruction was performed using anterolateral, anteromedial and accessory anteromedial portals. The first tunnel made was the AM femoral; the arthroscope was positioned in the anterolateral portal and the tunnel was drilled in its anatomical position from the anteromedial portal, with the knee at 120 degrees of flexion. The second tunnel made was the PL femoral; the arthroscope was positioned in the anteromedial portal and the tunnel was drilled in its anatomical position from the accessory anteromedial portal, with the knee at 120 degrees of flexion. The next tunnels to be made were the tibial PL and AM. The entry point of the PL tunnel was anterior to the fibers of the superficial medial collateral ligament, with the tibial guide adjusted to 55 degrees. The entry point of the AM tunnel was more lateral, leaving a bone bridge of at least 1 cm between the tunnels, with the tibial guide adjusted to 45 degrees. The graft for the PL bundle was passed through the tunnel first, followed by the AM. Both bundles were fixed with a biodegradable interference screw in the femur and a biodegradable interference screw in the tibia. The AM bundle was fixed with the knee at 45 degrees of flexion, and the PL with the knee at 15 degrees of flexion.

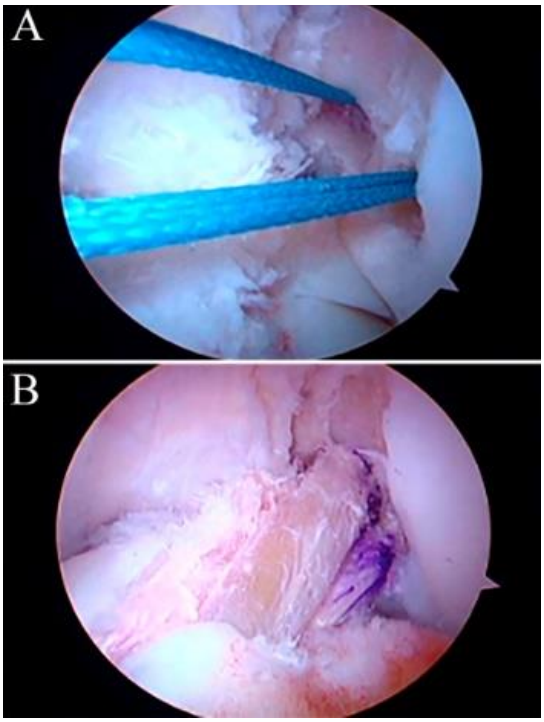

Figure 1. Intraoperative ACL reconstruction images using the double bundle technique. (A) arthroscopic view of the femoral tunnels. (B) arthroscopic view of the double-bundle ligament reconstruction

Results

Sixty-nine patients who met the inclusion criteria were included. The baseline data (pre-reconstruction) of the studied group are shown [Table 1].

Double-bundle post-reconstruction data were collected for a mean follow-up period of 8.7 years. The surgical outcomes are shown in [Table 2].

The overall ACL survival curve following the reconstruction using double bundle is shown in [Figure 2A]. Of the 10 cases that suffered re-injury, eight presented mature grafts at least six months after reconstruction, as shown in MRI. Of the total, nine underwent revision surgery, but no case required osteotomy or extra-articular surgery. Two cases (20%) suffered retear before one year of follow-up while practicing sport and with grafts that had been shown to be mature, according to the same criteria. Not all patients performed all the tests recommended by our group as discharge criteria (Y test, hop test, Isokinetic hip and knee test).

In the group studied, although there was a greater tendency towards retear in the athletes, this correlation was not significant neither in the cumulative number of cases (p=0.145) [Table 3] nor in the survival comparison (p=0,168) [Figure 2B].

Similarly, no correlation was found between the higher re-injury rate in cases of revision reconstruction compared to primary reconstructions neither in the cumulative number of cases (p=0.601) [Table 4] nor in the survival comparison (p=0,940) [Figure 2C].

Table 1. Demographic data

Enrolled cases	69
Female/ Male	17 (25%)/ 52 (75%)
Age (years)	30 ± 10.2 (15-54)
Follow-up (years)	8.7 ± 1.6 (5-11.8)
Primary surgery	47 (68%)
Athletes	49 (71%)
Contralateral ACL rupture	26 (38%)

Data are shown as mean ± standard deviation (minimum - maximum) or in absolute values (percentage of total cases)

Table 2. Surgical outcomes

Return to sport	67 (97%)
Return to sport at the same level	50 (75%)
Incidence of retear	10 (14%)
Postoperative time until retear (months)	32 ± 15 (9-50)
Pain level (last follow-up; 0-100)	18 (26%)
Incidence of instability (last follow-up)	8 (12%)
Incidence of stiffness (last follow-up)	1 (1%)

Data are shown as mean ± standard deviation (minimum - maximum) or in absolute values (percentage of total cases)

Table 3. Incidence of retear in athlete and non-athletes

	Athlete	Non-Athlete	Total
Retear	9	1	10
No Retear	40	19	59
Total	49	20	69

Table 4. Incidence of re-injury in primary and revision surgeries

	Primary	Revision	Total
Retear	7	3	10
No retear	40	19	59
Total	47	22	69

Discussion

Since 2006, we have performed the DB technique in our group, mainly in amateur or federated athletes with competitive demands, but without abandoning the single-bundle technique. Since that time, we have performed the single-bundle technique through the anteromedial portal, seeking to achieve more anatomical reconstruction. The surgeries of this study were performed using the same technique, by four more senior surgeons of our group, three of whom are authors of this study. This is a line of research of our group. In addition to this study, we are currently conducting a comparative cohort of athletes submitted to primary ACL reconstruction surgeries with the single and double bundle techniques, and a comparative study of knee rotation comparing double bundle with single-bundle reconstruction associated with the anterolateral ligament.

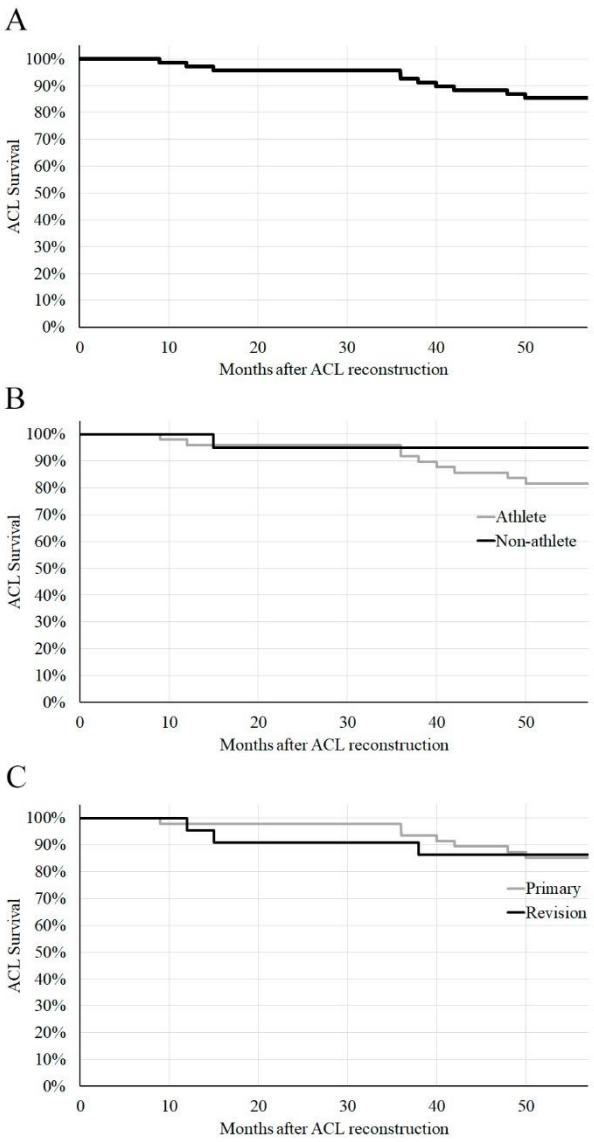

Figure 2. Kaplan-Meier survival curves to indicate time of re-injury after double-bundle anterior cruciate ligament reconstruction up to the minimum follow-up period. (A) All cases studied in this work. (B) Individuals divided into athlete and non-athlete subgroups (p=0.168; Log Rank test, Mantel-Cox). (C) Individuals divided into primary and revision surgery subgroups (p=0.940; Log Rank test, Mantel-Cox).

In 2010, a national study describing the methodology for evaluating knee rotation presented initial results comparing the knee reconstructed with double bundle and the contralateral knee (18). In 2014, D'Elia et al. conducted a similar study, and found no significant differences in knee rotation in the laboratory using the same methodology as that used in the patients submitted to ACL reconstruction with double bundle, when compared to single-bundle reconstruction (19). However, this study did not compare clinical outcomes, recurrence rates and/or return to medium/long-term sports. It only investigated the short-term biomechanical results of patients considered clinically successful, in order to evaluate tibial rotation.

In our current study of 69 patients, the most significant results were a 14% re-injury rate after an average of 8.7 years of surgery. These rates were similar in primary and revision cases, and with a tendency towards greater re-injury among athletes compared to non-athletes. We also found a high rate of return to sport of 97%, with 75% of these performing at the same level as before the injury.

In relation to the rate of re-injury, the rates shown in the literature range from 6% to 31% (20). Higher rates are found in athletes and according to a meta-analysis by Wiggins et al. in 2016, this rate increases to 25% among young athletes under the age of 25 (21).

When we compare our rate of 14% with the rates reported by studies with at least five years of follow-up, we believe our results are comparable and positive, as ours is a sample with many athletes (71%) and with revision cases, in which the retear rate increases, as demonstrated by George, Dunn and Spinder (24% revision surgeries vs 7% primary surgeries) (22). Suomalainen et al., in 2012, demonstrated re-injury rates of 25% in patients submitted to SB reconstruction compared to 10% for those submitted to DB (23). Finally, Grassi et al., in a more recent review with a minimum five-year follow-up, reported a cumulative failure rate (graft + objective scores and instability) of more than 5% in all but one of the 16 series studied (24); more than 10% in 12 of 16 of the series studied, and more than 20% in five series. Finally, a study by Yoon et al. demonstrates 15-year survival following ACL reconstruction of 82.1% for SB and 83.7% for DB, in a comparative study with the longest follow-up time of any found in the literature (25). We believe that the high and variable rates demonstrate that this is a multifactorial cause involving both technical surgical issues, biology and graft integration, and postoperative neuromuscular control. In some cases of failure of our study, the patients did not follow our discharge criteria by taking all the laboratory tests, corroborating data presented by Kyritsis et al. and other groups that demonstrate the importance of neuromuscular control in preventing retear (26).

Regarding return to sport, we believe that we have good rates of return to sport in the athletes of our sample: 97%, of which 75% returned to sport at the same pre-injury level. Sepúlveda et al. in a literature review conducted in 2017, show that 81% of patients return to sport, 65% at pre-injury levels (27). Lai et al. in 2018 reported that this rate of return to pre-injury levels is higher among elite athletes (83%) (28). Finally, Volpi et al., in a case series of DB patients with 4 to 11 years of follow-up, report that 100% returned to sport; 90.5% to the same levels as before the injury (29).

Our study has some limitations, which are mostly related to the retrospective, non-comparative study design. In addition, the low number of patients included may have led to an underestimation of differences between the subgroups compared. Also, we did not present clinical scores, and we did not evaluate the progression of

arthrosis, an important long-term outcome. Finally, we had a high loss to follow-up (51%), considering all the patients operated with the technique of interest during the period in question. The percentage of loss to follow-up that is tolerated in case series is much debated, with authors citing that 50% would be adequate, but that loss of below 20% is the ultimate goal (30). It should also be considered that this loss of will be greater in series with longer follow-up times.

However, we believe that our current study is relevant because it was performed at the same center, using the same technique, with a long follow-up time, and because it evaluates two outcomes that have not been investigated previously in the literature: the rate of return to sport and the rate of long-term re-injury.

In our series of patients operated on with the double-bundle technique and with long follow-up times, 14% presented re-injury, with no differences between primary and revision cases, and with a tendency towards higher re-injury among athletes compared to non-athletes. We had satisfactory rates of return to the sport of 97%, with 75% of these returning to pre-injury levels.

This study was approved by the Research Ethics Committee (Hospital Moriah, under approval number 00513418.4.0000.8054) and it received waiver regarding the consent forms following all applicable local ethics regulamentation.

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Conflict of interests: Declarations of interest: Wagner Castropil is a paid consultant for DePuy Synthes; All other authors declare no potential conflict of interest

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REFERENCES

1. Zhu Y, Jiang C, Song G. Arthroscopic Versus Open Latarjet in the Treatment of Recurrent Anterior Shoulder Dislocation with Marked Glenoid Bone Loss: A Prospective Comparative Study. Am J Sports Med. 2017;45(7):1645–53.
2. Georgoulis AD, Ristanis S, Chouliaras V, Moraiti C, Stergiou N. Tibial rotation is not restored after ACL reconstruction with a hamstring graft. Clin Orthop Relat Res. 2007;Jan(454):89–94.
3. Ahlden M, Sernert N, Karlsson J, Kartus J. A prospective randomized study comparing double- and single-bundle techniques for anterior cruciate ligament reconstruction. Am J Sports Med. 2013;41(11):2484–91.
4. Komzák M, Hart R, Feranec M, Šmíd P, Kocová R. In vivo knee rotational stability 2 years after double-bundle and anatomic single-bundle ACL reconstruction. Eur J Trauma Emerg Surg. 2018;44(1):105–11.
5. Kondo E, Merican AM, Yasuda K, Amis AA. Biomechanical comparisons of knee stability after anterior cruciate ligament reconstruction between 2 clinically available transtibial procedures: Anatomic double bundle versus single bundle. Am J Sports Med. 2010;38(7):1349–58.
6. Björnsson H, Desai N, Musahl V, Alentorn-Geli E, Bhandari M, Fu F, et al. Is double-bundle anterior cruciate ligament reconstruction superior to single-bundle? A comprehensive systematic review. Knee Surgery, Sport Traumatol Arthrosc. 2015;23(3).
7. Qiu X-S, Jiang H, Qian B-P, Wang W-J, Zhu F, Zhu Z-Z, et al. Influence of prone positioning on potential risk of aorta injury from pedicle screw misplacement in adolescent idiopathic scoliosis patients. 27(5):E162--167.
8. Zaffagnini S, Bruni D, Marcheggiani Muccioli GM, Bonanzinga T, Lopomo N, Bignozzi S, et al. Single-bundle patellar tendon versus non-anatomical double-bundle hamstrings ACL reconstruction: a prospective randomized study at 8-year minimum follow-up. Knee Surg Sports Traumatol Arthrosc. 2011;19(3):390–7.
9. Jarvela T. Double-bundle versus single-bundle anterior cruciate ligament reconstruction: a prospective, randomize clinical study. Knee Surg Sport Traumatol Arthrosc. 2007;15(5 SRC-BaiduScholar FG-0):500–7.
10. Kong L, Liu Z, Meng F, Shen Y. Single-bundle versus double-bundle anterior cruciate ligament reconstruction: A systematic review and meta-analysis. Int J Clin Exp Med. 2017;10(1):1–15.
11. Järvelä T, Moisala A-S, Sihvonen R, Järvelä S, Kannus P, Järvinen M. Double-bundle anterior cruciate ligament reconstruction using hamstring autografts and bioabsorbable interference screw fixation: prospective, randomized, clinical study with 2-year results. Am J Sports Med. 2008;36:290–7.
12. Yoon JW, Wang MY. The evolution of minimally invasive spine surgery. Spine J. 2019;30:149–58.
13. Dong Z, Niu Y, Qi J, Song Y, Wang F. Long term results after double and single bundle ACL reconstruction: Is there any difference? A meta - analysis of randomized controlled trials. Acta Orthop Traumatol Turc. 2019 Mar 1;53(2):92–9.
14. Järvelä S, Kiekara T, Suomalainen P, Järvelä T. Double-Bundle Versus Single-Bundle Anterior Cruciate Ligament Reconstruction: A Prospective Randomized Study With 10-Year Results. Am J Sports Med. 2017;45(11):2578–85.
15. Svantesson E, Sundemo D, Hamrin Senorski E, Alentorn-Geli E, Musahl V, Fu FH, et al. Double-bundle anterior cruciate ligament reconstruction is superior to single-bundle reconstruction in terms of revision frequency: a study of 22,460 patients from the Swedish National Knee Ligament Register. Knee Surgery, Sport Traumatol Arthrosc. 2017 Dec 1;25(12):3884–91.
16. Mayr HO, Bruder S, Hube R, Bernstein A, Suedkamp NP, Stoehr A. Single-Bundle Versus Double-Bundle Anterior Cruciate Ligament Reconstruction—5-Year Results. Arthrosc - J Arthrosc Relat Surg. 2018 Sep 1;34(9):2647–53.
17. Mohtadi NG, Chan DS. A Randomized Clinical Trial Comparing Patellar Tendon, Hamstring Tendon, and Double-Bundle ACL

Reconstructions: Patient-Reported and Clinical Outcomes at 5-Year Follow-up. J Bone Jt Surg - Am Vol. 2019 Jun 5;101(11):949–60.

18. D'Elia CO, Bitar AC, Castropil W, Garofo AGP, Cantuária AL, Orselli MIV, et al. Anterior cruciate ligament reconstruction using the double bundle technique - evaluation in the biomechanics laboratory. Rev Bras Ortop. 2011;46(2):148–54.
19. D'Elia CO. Estudo comparativo da avaliação da rotação dos joelhos submetidos à reconstrução do ligamento cruzado anterior: feixe duplo x feixe simples [Internet]. Faculdade de Medicina da Universidade de São Paulo; 2014. Available from: https://www.teses.usp.br/teses/disponiveis/5/5140/tde-16032015-151434/publico/CaioOliveiraDelia.pdf
20. Wright RW, Magnussen RA, Dunn WR, Spindler KP. Ipsilateral graft and contralateral ACL rupture at five years or more following ACL reconstruction: A systematic review. J Bone Jt Surg - Ser A. 2011 Jun 15;93(12):1159–65.
21. Wiggins AJ, Grandhi RK, Schneider DK, Stanfield D, Webster KE, Myer GD. Risk of Secondary Injury in Younger Athletes after Anterior Cruciate Ligament Reconstruction. Vol. 44, American Journal of Sports Medicine. SAGE Publications Inc.; 2016. p. 1861–76.
22. George MS, Dunn WR, Spindler KP. Current concepts review: Revision anterior cruciate ligament reconstruction. Vol. 34, American Journal of Sports Medicine. 2006. p. 2026–37.
23. Suomalainen P, Järvelä T, Paakkala A, Kannus P, Järvinen M. Double-bundle versus single-bundle anterior cruciate ligament reconstruction: A prospective randomized study with 5-year results. Am J Sports Med [Internet]. 2012 Jul [cited 2020 Oct 7];40(7):1511–8. Available from: https://pubmed.ncbi.nlm.nih.gov/22691456/
24. Grassi A, Kim C, Marcheggiani Muccioli GM, Zaffagnini S, Amendola A. What Is the Mid-term Failure Rate of Revision ACL Reconstruction? A Systematic Review. Clin Orthop Relat Res. 2017 Oct 1;475(10):2484–99.
25. Yoon KH, Kim JS, Kim SJ, Park M, Park SY, Park SE. Eight-year results of transtibial nonanatomic single-bundle versus double-bundle anterior cruciate ligament reconstruction: Clinical, radiologic outcomes and survivorship. J Orthop Surg (Hong Kong) [Internet]. 2019 [cited 2020 Jan 27];27(2):2309499019840827. Available from: http://www.ncbi.nlm.nih.gov/pubmed/30955412
26. Kyritsis P, Bahr R, Landreau P, Miladi R, Witvrouw E. Likelihood of ACL graft rupture: Not meeting six clinical discharge criteria before return to sport is associated with a four times greater risk of rupture. Br J Sports Med. 2016 Aug 1;50(15):946–51.
27. Sepúlveda F, Sánchez L, Amy E, Micheo W. Anterior cruciate ligament injury: Return to play, function and long-term considerations. Curr Sports Med Rep. 2017 Jun 1;16(3):172–8.
28. Lai CCH, Ardern CL, Feller JA, Webster KE. Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: A systematic review with meta-analysis of return to sport rates, graft rupture rates and performance outcomes. In: British Journal of Sports Medicine. BMJ Publishing Group; 2018. p. 128–38.
29. Volpi P, Quaglia A, Carimati G, Galli M, Papalia R, Petrillo S. Double bundle anterior cruciate ligament reconstruction: Failure rate and patients-reported outcomes at 4-11 years of follow up. J Orthop. 2019;16(3):224–9.
30. Babbie ER. Survey research methods. Wadsworth Pub. Co; 1973. 383 p.