



The Role of Lateral Retinacular Release in Preventing Patellofemoral Malalignment in Double-Bundle Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Trial

Ludwig Andre Pontoh, MD, Ismail Hadisoebroto Dilogo, MD*, Erica Kholinne, MD[†],
Jessica Fiolin, MD*, Toto Suryo Efar, MD*

Knee Division of Department of Orthopaedic and Traumatology, Fatmawati General Hospital, Faculty of Medicine Universitas Indonesia, Jakarta,

**Department of Orthopaedic and Traumatology, Cipto Mangunkusumo Hospital, Faculty of Medicine Universitas Indonesia, Jakarta,*

[†]Department of Surgery, St. Carolus Hospital, Jakarta, Indonesia

Background: Loss of internal rotation stability is the major cause of pain after an anterior cruciate ligament reconstruction (ACLR). Many authors described measures to treat this problem to no avail. This is the first study evaluating the role of lateral release with double-bundle ACLR to prevent patellofemoral malalignment after ACLR.

Methods: A total of 100 patients were included in this prospective study between January 2018 and December 2019. We compared single-bundle ACLR (group 1, n = 30), double-bundle ACLR (group 2, n = 30), and double-bundle ACLR with lateral release (group 3, n = 40). Clinical outcome was evaluated with the Kujala score while radiological outcome was evaluated using the tibial tubercle-trochlear groove (TTTG) distance in magnetic resonance imaging. The preoperative and postoperative values were compared.

Results: At the final follow-up of 6–18 months, group 3 showed the lowest TTTG value (6.7 ± 4.69) compared to group 2 (9.1 ± 4.83) and group 1 (11.74 ± 1.76) ($p = 0.03$). The Kujala score was significantly improved in all groups: from 68.83 to 89.90 in group 1, from 70.02 to 91.23 in group 2, and from 69.71 to 95.05 in group 3 ($p = 0.03$). Group 3 showed the most superior improvement in the Kujala score (25.34) compared to group 1 (21.07) and group 3 (21.21) ($p = 0.012$).

Conclusions: Concomitant lateral retinacular release significantly improved the Kujala score. It may serve as a valuable option to overcome patellofemoral pain syndrome in ACLR.

Keywords: Anterior cruciate ligament reconstruction, Double-bundle, Lateral release, Patellofemoral malalignment, Tibial tubercle trochlear groove

The anterior cruciate ligament (ACL) acts as the primary

anterior stabilizer and also aids in rotatory stability.¹⁾ An isolated ACL rupture may significantly elongate the patellar tendon, which will result in patellar malalignment²⁾ and cause rotatory knee instability. Hence, the patellofemoral cartilage contact area will be shifted to a more proximal and lateral area and cause patellofemoral pain syndrome (PFPS).^{3,4)}

Reconstruction of the ACL has come a long way due to newer techniques and recent technologies;⁵⁻⁷⁾ however, current strategies to solve the patellofemoral problem are

Received December 2, 2020; Revised March 9, 2021;
Accepted August 6, 2021

Correspondence to: Ludwig Andre Pontoh, MD
Knee Division of Department of Orthopaedic and Traumatology, Fatmawati General Hospital, Faculty of Medicine Universitas Indonesia, Jl. RS Fatmawati No. 4, Jakarta Selatan 12430, Indonesia
Tel: +62-2-1750-1524, Fax: +62-8-1698-4658
E-mail: andrepontoh@gmail.com

not satisfying.⁵⁾ Several literatures have mentioned measures to overcome this problem including double-bundle anterior cruciate ligament reconstruction (DB-ACLR),^{5,6)} anterolateral tenodesis,^{7,8)} and anterolateral ligament reconstruction.⁹⁾ Gong et al.⁵⁾ showed that DB-ACLR had less cartilage damage at the femoral trochlea in a short-term follow-up than single-bundle ACLR (SB-ACLR). Another study showed that DB-ACLR restored the normal patellofemoral contact area and pressure more closely than SB-ACLR.⁶⁾ However, residual rotational laxity, which results in pain following ACLR, was still seen following the procedures.⁷⁻⁹⁾

The current study aimed to investigate the role of concomitant lateral release (LR) procedure in ACLR. We hypothesized that the concomitant LR procedure in ACLR would improve the functional outcome and reduce PFPS caused by patellofemoral maltracking following surgery.

METHODS

The study was granted ethical approval of Faculty of Medicine Universitas Indonesia Ethical Committee (No. 758/UN2.F1/ETIK/2014). Participants of this study received oral and written information about the study, after which written consent was obtained.

Between January 2018 and December 2019, a total of 100 patients who were to undergo arthroscopic ACLR were enrolled in a prospective randomized controlled study. All ACL reconstructions were conducted by the same surgeon (LAP).

Indication of the surgery was an acute or chronic isolated ACL rupture. Inclusion criteria were as follow: (1) unilateral isolated complete ACL rupture; (2) age, 16–40 years; (3) normal body mass index (BMI: 18.5–24.9 kg/m²); (4) signs and symptoms in physical examination consistent with the diagnosis of ACL rupture and magnetic resonance imaging (MRI) indicating ACL injury (MRI 3.0-Tesla Magnetom Skyra; Siemens Medical Solutions, Malvern PA, USA); and (5) no previous surgery in the index knee. The exclusion criteria were (1) existence of flexion contracture more than 20°, (2) presence of anterior knee pain prior surgery, (3) Q angle > 14° in males and > 17° in females, (4) presence of patellar tilting (positive J-sign), and (5) muscular dysfunction (Medical Research Council scale for muscle strength < 5).

Patients were randomized to undergo SB-ACLR (group 1, n = 30), DB-ACLR (group 2, n = 30), or DB-ACLR with concomitant LR (group 3, n = 40) (Fig. 1). Randomization was performed by one of the authors (TSE) using the block randomization technique with use of an online randomization generator (<http://www.graphpad.com/quickcalcs>) and another author (IHD) assigned participants to interventions.

Surgical Technique

Standard medial and lateral arthroscopic portals were established adjacent to the patellar tendon prior to routine diagnostic arthroscopy to confirm the diagnosis of ACL tear and find any concurrent injuries. All reconstructions were performed with hamstring autografts.

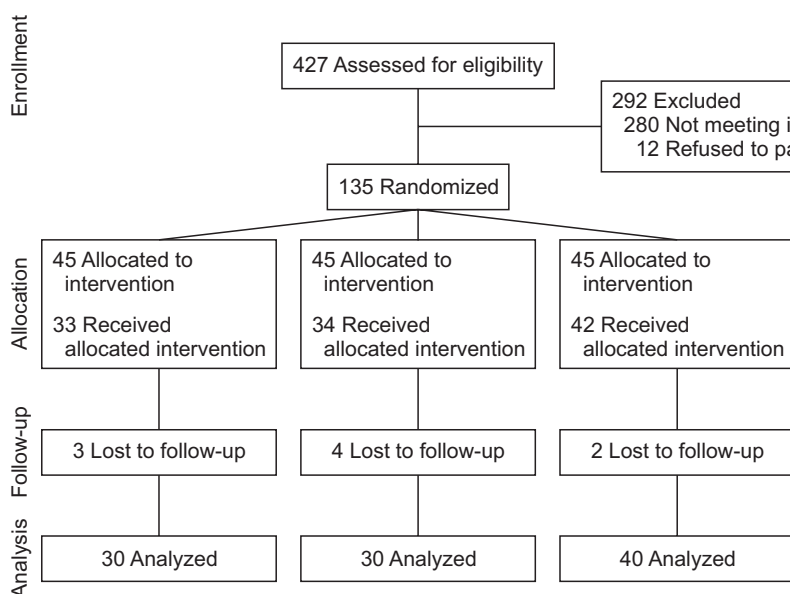


Fig. 1. Schematic chart of the patient enrollment.

SB-ACLR

The tibial tunnel was first created by drilling at the center of the ACL footprint. Meanwhile, the femoral tunnel was created by drilling at the anatomic anteromedial bundle through the anteromedial portal, while the knee was in 120° flexion position. After all tunnels were created, the graft was pulled through the tibial tunnel into the femoral tunnel. Graft fixation was done with suspensory fixation (Endobutton; Smith & Nephew, Andover, MA, USA) and bioabsorbable interference screws (Biosure, Smith & Nephew) for the femoral site and tibial site, respectively. The graft was then tensioned with the knee in slight flexion before fixation at the tibial tunnel.

DB-ACLR

The anteromedial bundle and posterolateral bundle attachments in the femoral site were identified with a guide wire through a far anteromedial portal. The anteromedial and posterolateral bundles were determined according to the resident's ridge. In the sagittal plane, tunnels for the anteromedial bundle and posterolateral bundle were placed 3 mm posterior to the resident's ridge.¹⁰ Bone tunnels for the anteromedial and posterolateral bundles were drilled over the guide wire when the knee was flexed greater than 120°. The tibial tunnels were created using two 2.4-mm guide wires inserted into the center of the anteromedial and posterolateral bundle footprints. Graft passage and fixation were performed similar to SB-ACLR.

LR

The lateral retinaculum release was performed through the suprapatellar portal as a viewing portal following the DB-ACLR. The radiofrequency ablator (Arthrocare, Mitek; Depuy, Raynham, MA, USA) was used to perform the release continuously through the capsule and the lateral retinaculum extending from and including the vastus lateralis tendon to the joint line, passing approximately 1–1.5 cm lateral to the patella (Fig. 2). After the lateral retinacu-

lum release was performed, the patella trajectory was evaluated to ensure the patella was tracking at the center of the trochlea.

Postoperative Rehabilitation Protocol

Postoperatively all patients who underwent surgery received an appropriate analgesia and followed the same standard rehabilitation protocol according to our hospital protocol with a minimum of 6-month follow-up.^{11,12}

Outcome Assessment

Functional outcome

The functional outcomes of the patients were evaluated by an orthopedic surgeon who did not participate directly in the surgery (JF). The Kujala score, which consists of 13 knee-specific questions, is commonly used to evaluate patellofemoral joint pain. Patient's responses on patellofemoral joint-related disorders were assessed according to the scores including walking, running, jumping, stair climbing, squatting, swelling, and knee stiffness. Preoperative and 6-month postoperative scores were compared between groups.

Radiologic outcome

Preoperative tibial tubercle-trochlear groove (TTTG) distance was measured between the tibial tuberosity and the deepest point of the trochlear groove on an axial T2-weighted MRI 3.0T Magnetom Skyra (Siemens Medical Medical Solutions, Malvern, PA, USA) in supine position.¹¹ According to Pandit et al.,¹⁰ the normal value for TTTG in men and women is 10 ± 1 mm. In the current study, we used the technique suggested by Pandit et al.¹⁰ by first measuring the midpoint of the distal insertion of the patellar tendon at the tibial tuberosity and then the images were scrolled proximally to the first image that depicted a complete cartilaginous trochlear groove. A reference line at the posterior femoral condyles was drawn and a second line from the deepest point of the trochlear groove

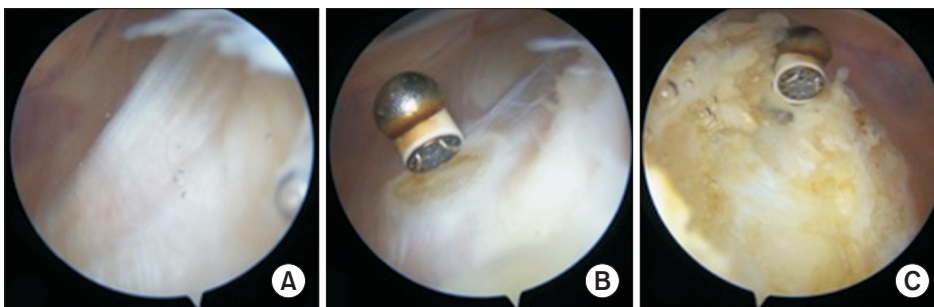


Fig. 2. Arthroscopic lateral release (LR) performed using a lateral suprapatellar portal. (A) Before LR. (B) During LR. (C) After LR.

perpendicular to this reference line was marked. Another line was drawn perpendicular to the reference line and the distance between these two perpendicular lines was measured as TTTG (Fig. 3). The radiological evaluation of the patients was performed by an orthopedic surgeon who did not participate directly in the surgery (EK). Preoperative and postoperative TTTG distance were compared between groups.

Statistical Analysis

The mean and standard deviation values are presented. The data were analyzed with IBM SPSS ver. 22.0 (IBM Corp., Armonk, NY, USA). The TTTG distance and Kujala score were analyzed using Mann-Whitney and Wilcoxon ranked test. The level of statistical significance was set at $p < 0.05$. To detect 10 points as the minimal clinically important difference for the Kujala score between the three groups with 80% power and a two-sided alpha error of 5%, 71 patients were needed as a sample size.¹³⁾

RESULTS

Patient Characteristics

Between January 2018 and December 2019, there were a total of 427 patients who went to a sport clinic with a complaint of knee pain. Out of 292 patients who were excluded, 280 did not meet the inclusion criteria and 12 patients refused to participate. A total of 135 patients were randomized into three groups; however, only 100 patients were analyzed in this study (Table 1). Patients were normally distributed in regards to age, weight, height, and BMI. There were no complications found at postoperative outcome.

Functional Outcome

There was no difference in the Kujala score preoperatively ($p = 0.437$). Postoperatively, all three groups showed significant improvement in the Kujala score compared to preoperative scores ($p < 0.01$). However, group 3 showed

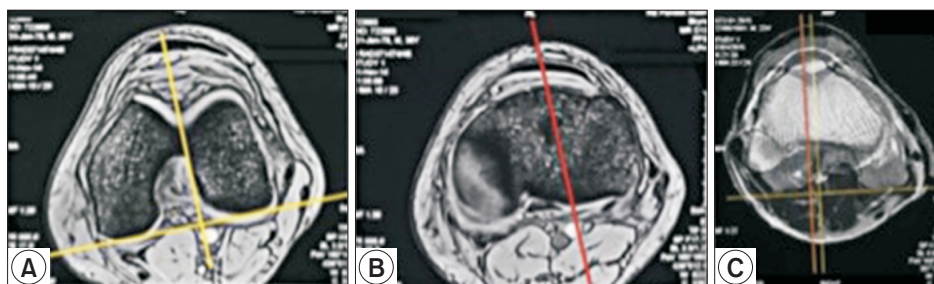


Fig. 3. Measurement of the tibial tubercle-trochlear groove (TTTG) distance¹¹⁾ in the magnetic resonance imaging axial view. The TTTG distance is measured by creating a line (vertical yellow line) along the trochlear groove at the midpoint of a projected reference line connecting two femoral condyles (A) and a second line (red line), which is drawn parallel to the first line at the most anterior part of the tibial tubercle (B). (C) TTTG is the distance between these two parallel lines (yellow line-red line), which represents tibial rotation in relation to the femur.

Table 1. Patient Characteristics

| Characteristics | Group 1 | Group 2 | Group 3 | p-value |
|--------------------------------------|---------------|---------------|--------------|---------|
| Sex | | | | |
| Male | 19 | 16 | 18 | 0.305 |
| Female | 11 | 14 | 12 | 0.411 |
| Age (yr) | 29 ± 5.90 | 26 ± 4.30 | 27 ± 4.20 | 0.277 |
| Weight (kg) | 72 ± 9.00 | 68 ± 4.30 | 70 ± 8.70 | 0.344 |
| Height (m) | 1.65 ± 0.18 | 1.66 ± 0.22 | 1.68 ± 0.19 | 0.228 |
| Body mass index (kg/m ²) | 23.45 ± 32.00 | 23.13 ± 27.00 | 22.81 ± 0.02 | 0.413 |

Values are presented as mean ± standard deviation.

Group 1: single-bundle ACLR, Group 2: double-bundle ACLR, Group 3: double-bundle ACLR with concomitant lateral release, ACLR: anterior cruciate ligament reconstruction.

the highest score (95.05) compared to other groups ($p = 0.030$) and the highest improvement in the Kujala score (25.34) ($p = 0.012$) (Table 2).

Radiologic Outcome

TTTG distance

Group 1 had the highest baseline TTTG in endorotation, which was 13.82 ± 2.71 , followed by group 2 (11.7 ± 3.75) and group 3 (10.9 ± 3.26). However, there was no significant difference in the preoperative baseline values of all groups ($p = 0.105$). Meanwhile, for the postoperative TTTG evaluation, group 3 had the lowest postoperative TTTG value, which was 6.7 ± 4.69 , compared with group 2 (9.1 ± 4.83) and group 1 (11.74 ± 1.76) ($p = 0.030$). There were, however, no significant difference between preoperative and postoperative TTTG values in all groups ($p = 0.072$) (Table 3). There was no statistically significant difference between the preoperative and postoperative TTTG values in group 1 ($p = 0.247$). However, significant differences after surgery were found in both group 2 ($p < 0.001$) and group 3 ($p < 0.001$) (Fig. 4).

DISCUSSION

The most important finding in this study is that a relatively simple procedure added substantial benefit to the success of ACLR. Lateral retinacular release has been long

performed indiscriminately to treat patellofemoral joint problems with conflicting results.¹³⁻¹⁵ Theoretically, LR relieves abnormal posterior and lateral tethering of the patella that may lead to lateral tilt and subluxation. A shortened lateral retinaculum will result in excessive pressure on the lateral facet of the patella because when the knee flexes, the iliotibial band is drawn posteriorly and this will eventually cause cartilage degeneration on the overloaded lateral facet.¹⁶ Additional LR following a primary total knee arthroplasty (TKA) procedure in a tight retinaculum has been proven to correct patellar maltracking that often causes anterior knee pain after TKA.¹⁷

It has been reported that PFPS after ACLR is commonly the major cause of anterior knee pain, preventing patients' return to sports.¹⁸ Patellofemoral malalignment is commonly the main source of PFPS after an ACLR, causing an imbalance of the extensor mechanism and excessive pressure on the patellofemoral joint, and it may result in cartilage damage.^{19,20}

The TTTG distance is a measure of lateralization of the tibial tuberosity in relation to the femoral trochlea. Many studies have confirmed that lateralization of the tuberosity is linked to patellar instability, hence TTTG is an important parameter for patellofemoral disorders.^{11,12} The normal TTTG value is 10 ± 1 mm according to Pandit et al.¹⁰ The mean preoperative TTTG value in this study was between 10.9 and 13.82, indicating a more internally

Table 2. Preoperative, Postoperative, and Difference of Kujala Score within Groups

| Variable | Group 1 (n = 30) | Group 2 (n = 30) | Group 3 (n = 40) | p-value |
|-----------|------------------|------------------|------------------|---------|
| Pre-ACLR | 68.83 ± 3.17 | 70.02 ± 2.85 | 69.71 ± 3.25 | 0.437 |
| Post-ACLR | 89.90 ± 2.94 | 91.23 ± 1.45 | 95.05 ± 2.98 | 0.030 |
| Delta | 21.07 ± 1.02 | 21.21 ± 0.87 | 25.34 ± 2.21 | 0.012 |

Values are presented as mean \pm standard deviation.

Group 1: single-bundle ACLR, Group 2: double-bundle ACLR, Group 3: double-bundle ACLR with concomitant lateral release, ACLR: anterior cruciate ligament reconstruction.

Table 3. Preoperative, Postoperative, and Difference of TTTG Value within Groups

| Variable | Group 1 | Group 2 | Group 3 | p-value |
|-----------|------------------|-----------------|-----------------|---------|
| Pre-ACLR | 13.82 ± 2.71 | 11.7 ± 3.75 | 10.9 ± 3.26 | 0.105 |
| Post-ACLR | 11.74 ± 1.76 | 9.1 ± 4.83 | 6.7 ± 4.69 | 0.030 |
| Delta | 2.08 ± 0.95 | 2.6 ± 3.15 | 4.2 ± 3.62 | 0.072 |

Values are presented as mean \pm standard deviation.

TTTG: tibial tubercle-trochlear groove, Group 1: single-bundle ACLR, Group 2: double-bundle ACLR, Group 3: double-bundle ACLR with concomitant lateral release, ACLR: anterior cruciate ligament reconstruction.

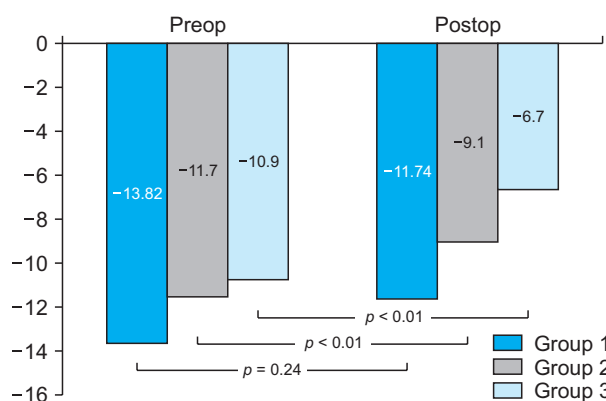


Fig. 4. Preoperative (Preop) and postoperative (Postop) comparison of the tibial tubercle-trochlear groove (TTTG) value in each group. A negative value indicates an endorotated tibia. There was statistically significant reduction in TTTG after anterior cruciate ligament reconstruction (ACLR) compared to the preoperative value in group 2 and group 3. Group 1: single-bundle ACLR, Group 2: double-bundle ACLR, Group 3: double-bundle ACLR with concomitant lateral release.

rotated tibia, which is commonly found in ACL-deficient patients according to Saper et al.¹⁶⁾

Several techniques have been developed to overcome patellofemoral malalignment after ACLR. The previous trend was to perform anatomic, independent femoral drilling reconstructions, resulting in a more oblique disposition of the graft and improved rotational control.^{21,22)} Unfortunately, residual pivot-shift is still high with this technique. Another technique promotes anterolateral tenodesis and recently the reconstruction of the anterolateral ligament has attracted increasing attention.^{23,24)} However, the proper anatomic insertions of the ligament are not clear and controversial results are described in the literature, such as compromised range of motion in case of improper placement.

A recent study of Kidera et al.²¹⁾ showed that DB-ACLR also improved tibial rotational instability during squatting motion using the two-dimensional/three-dimensional registration technique. However, there are many literatures showing considerable controversy regarding the SB versus DB graft, showing equivocal results in terms of reducing tibial rotation.^{6,22,23,25)} In an isolated total ACL tear, there was rotational laxity causing patellofemoral maltracking, which can be proven on an internally rotated tibial tubercle relative to the trochlea groove or negative TTTG. In this study, postoperatively there was a significant decrease in TTTG endorotation in groups 2 and 3.

The lowest TTTG value was observed in patients in group 3 (6.7 ± 4.69) compared to group 2 (9.1 ± 4.83) and group 1 (11.74 ± 1.76) ($p = 0.030$). This result shows that

although both DB and DB-LR procedures decrease TTTG endorotation significantly, DB-LR will decrease the TTTG distance more, albeit not statistically significant. The preoperative TTTG value showed an increase in internal rotation due to the loss of anterolateral stability produced by the torn ACL. The DB-LR group showed superiority in decreasing the TTTG value compared to other groups and also improving the Kujala score significantly compared to other groups ($p = 0.003$).

Arthroscopic LR procedure is not a new procedure; however, simultaneous performance with ACLR has never been reported. The idea to overcome internal rotational laxity after ACLR through patellofemoral realignment was either performing a lateral advancement of the tibia or releasing the patella, rendering its medial translation, hence creating patellofemoral realignment. Our study showed that DB-LR ACLR, when performed in isolated ACL ruptures, increased TTTG scores preoperatively and prevented PFPS within a period of 6–18 months postoperatively.

We recommend a simple, cheap, and safe technique to overcome PFPS by combining two well performed techniques, which were first introduced worldwide with quite satisfactory outcome. However, this study has several drawbacks including the lack of postoperative patellofemoral chondral evaluation, functional score analysis with longer duration of follow-up and larger sample, and long-term effect of LR such as pain and muscle weakness. Intraoperative objective measurement of LR needs to be studied in order to obtain a more optimum result. The current study was also presented with the 6-month follow-up period, which necessitates further research with a longer follow-up period. Concomitant lateral retinacular release in ACLR significantly improved the Kujala score compared to ACLR without LR; therefore, LR may serve as a valuable option to overcome PFPS in ACLR.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Ludwig Andre Pontoh

<https://orcid.org/0000-0001-8856-1977>

Ismail Hadisoebroto Dilogo

<https://orcid.org/0000-0003-4060-2260>

Erica Kholinne

<https://orcid.org/0000-0002-4326-8205>

Jessica Fiolin

<https://orcid.org/0000-0002-0213-5078>

Toto Suryo Efar

<https://orcid.org/0000-0002-7989-4312>

REFERENCES

1. Fu FH, van Eck CF, Tashman S, Irrgang JJ, Moreland MS. Anatomic anterior cruciate ligament reconstruction: a changing paradigm. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(3):640-8.
2. Hsieh YF, Draganich LE, Ho SH, Reider B. The effects of removal and reconstruction of the anterior cruciate ligament on the contact characteristics of the patellofemoral joint. *Am J Sports Med.* 2002;30(1):121-7.
3. Li G, DeFrate LE, Park SE, Gill TJ, Rubash HE. In vivo articular cartilage contact kinematics of the knee: an investigation using dual-orthogonal fluoroscopy and magnetic resonance image-based computer models. *Am J Sports Med.* 2005;33(1):102-7.
4. Colombet P, Jenny JY, Menetrey J, Plaweski S, Zaffagnini S; French Arthroscopy Society (SFA). Current concept in rotational laxity control and evaluation in ACL reconstruction. *Orthop Traumatol Surg Res.* 2012;98(8 Suppl):S201-10.
5. Gong X, Jiang D, Wang YJ, Wang J, Ao YF, Yu JK. Second-look arthroscopic evaluation of chondral lesions after isolated anterior cruciate ligament reconstruction: single- versus double-bundle reconstruction. *Am J Sports Med.* 2013; 41(10):2362-7.
6. Tajima G, Iriuchishima T, Ingham SJ, et al. Anatomic double-bundle anterior cruciate ligament reconstruction restores patellofemoral contact areas and pressures more closely than nonanatomic single-bundle reconstruction. *Arthroscopy.* 2010;26(10):1302-10.
7. Guenther D, Irrarrazaval S, Bell KM, et al. The role of extra-articular tenodesis in combined ACL and anterolateral capsular injury. *J Bone Joint Surg Am.* 2017;99(19):1654-60.
8. Sonnery-Cottet B, Thaunat M, Freychet B, Pupim BH, Murphy CG, Claes S. Outcome of a combined anterior cruciate ligament and anterolateral ligament reconstruction technique with a minimum 2-year follow-up. *Am J Sports Med.* 2015;43(7):1598-605.
9. Wittstein JR, Bartlett EC, Easterbrook J, Byrd JC. Magnetic resonance imaging evaluation of patellofemoral malalignment. *Arthroscopy.* 2006;22(6):643-9.
10. Pandit S, Frampton C, Stoddart J, Lynskey T. Magnetic resonance imaging assessment of tibial tuberosity-trochlear groove distance: normal values for males and females. *Int Orthop.* 2011;35(12):1799-803.
11. Pontoh LA, Dilogo IH, Bardosono S, Lubis AM, Harahap AR, Pandelaki J, et al. Modified exorotation graft tension for tibial fixation in anterior cruciate ligament reconstruction: a randomized controlled trial. *Med J Indones.* 2018;27(3): 169-77.
12. 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;454:89-94.
13. Smith TO, Davies L, O'Driscoll ML, Donell ST. An evaluation of the clinical tests and outcome measures used to assess patellar instability. *Knee.* 2008;15(4):255-62.
14. Oliveira JP, Fonseca F, Noronha JC. Anterior knee pain and sensitivity after anterior cruciate ligament: its impact on sports. *OA Orthopaedics.* 2013;1(2):13.
15. Berruto M, Ferrua P, Carimati G, Uboldi F, Gala L. Patellofemoral instability: classification and imaging. *Joints.* 2013; 1(2):7-14.
16. Saper MG, Popovich JM Jr, Fajardo R, Hess S, Pascotto JL, Shingles M. The relationship between tibial tubercle-trochlear groove distance and noncontact anterior cruciate ligament injuries in adolescents and young adults. *Arthroscopy.* 2016;32(1):63-8.
17. Zhang C, Xu H, Li X, Wang Y, Zhang Q, Zhu Q. Oblique femoral tunnel or oblique graft? A modified anteromedial portal technique to obtain vertical femoral tunnel and oblique graft in anatomic anterior cruciate ligament reconstruction. *Eur J Orthop Surg Traumatol.* 2013;23(6):731-5.
18. Slette EL, Mikula JD, Schon JM, et al. Biomechanical results of lateral extra-articular tenodesis procedures of the knee: a systematic review. *Arthroscopy.* 2016;32(12):2592-611.
19. Saithna A, Thaunat M, Delaloye JR, Ouanezar H, Fayard JM, Sonnery-Cottet B. Combined ACL and anterolateral ligament reconstruction. *JBJS Essent Surg Tech.* 2018;8(1):e2.
20. Delaloye JR, Murar J, Vieira TD, et al. Combined anterior cruciate ligament repair and anterolateral ligament reconstruction. *Arthrosc Tech.* 2018;8(1):e23-9.
21. Kidera K, Yonekura A, Miyaji T, et al. Double-bundle anterior cruciate ligament reconstruction improves tibial rotational instability: analysis of squatting motion using a 2D/3D registration technique. *J Orthop Surg Res.* 2018;13(1):111.
22. Misonoo G, Kanamori A, Ida H, Miyakawa S, Ochiai N. Evaluation of tibial rotational stability of single-bundle vs. anatomical double-bundle anterior cruciate ligament reconstruction during a high-demand activity - a quasi-randomized trial. *Knee.* 2012;19(2):87-93.
23. Ferretti A, Monaco E, Labianca L, De Carli A, Maestri B, Conteduca F. Double-bundle anterior cruciate ligament reconstruction: a comprehensive kinematic study using navigation. *Am J Sports Med.* 2009;37(8):1548-53.
24. Fonseca L, Kawatake EH, Pochini AC. Lateral patellar reti-

lateral release: changes over the last ten years. *Rev Bras Ortop.* 2017;52(4):442-9.

25. Post WR, Fulkerson JP. Surgery of the patellofemoral joint: indications, effects, results, and recommendations. In: Scott

WN, Insall JN, eds. *Insall & Scott surgery of the knee.* 4th ed. Philadelphia: Churchill Livingstone Elsevier; 2006. 945-7.