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Large variability exists in the management of posterolateral corner injuries in the global surgical community

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Abstract

Purpose The management of posterolateral corner (PLC) injuries has significantly evolved over the past 2 decades. The purpose of this study was to determine the current worldview of key concepts on the diagnosis, treatment strategy, and rehabilitation for patients presenting with PLC injuries.

Methods A 12-question multiple-choice online survey was designed to address key questions in the diagnosis, treatment, and rehabilitation of PLC injuries. The survey was distributed to the most important international sports medicine societies worldwide. Clinical agreement was defined as > 80% of agreement in responses and general agreement was defined as > 60% of agreement in responses.

Results 975 surgeons completed the survey with 49% from Europe, 21% from North America, 12% from Latin America, 12% from Asia, and smaller percentages from Africa and Oceania. Less than 14% of respondents manage more than ten PCL injuries yearly. Clinical agreement of > 80% was only evident in the use of MRI in the diagnosis of PLC injury. Responses for surgical treatment were split between isometric fibular-based reconstruction techniques and anatomically based fibular and tibial-based reconstructions. A general agreement of > 60% was present for the use of a post-operative brace in the early rehabilitation.

Conclusion In the global surgical community, there remains a significant variability in the diagnosis, treatment, and post-operative management of PLC injuries. The number of PLC injuries treated yearly by most surgeons remains low. As global clinical consensus for PLC remains elusive, societies will need to play an important role in the dissemination of evidence-based practices for PLC injuries.

Level of evidence IV.

Keywords Posterolateral corner injury · Survey study · Management

Introduction

Posterolateral corner (PLC) injuries of the knee are relatively common occurrences seen in approximately 9% of patients presenting with an acute traumatic knee hemarthrosis [13]. Previously, a limited understanding of the incidence, anatomical structures, biomechanics, and treatment options lead to inconsistent outcomes in patients with these injuries [6, 8]. However, in the last decades, robust anatomical and biomechanical directed reconstruction techniques as well as a better understanding of the diagnosis and natural history have led to improved recognition and patient outcomes [2].

Despite these advancements, there remains heterogeneity in high-level evidence guiding treatment algorithms for PLC injuries [3]. This may be a result of these injuries often presenting as part of a multi-ligamentous complex pattern rather than in isolation, as well as their lower incidence in comparison to single ligament injuries [13]. In a recent international expert consensus review on PLC, Chahla et al. identified multiple areas reaching an expert consensus such as diagnostic aids, timing of treatment, and the

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need for anatomical reconstruction of injured structures [3]. However, debate remains regarding the role of conservative management and minimally invasive treatment strategies for these injuries. In light of the recent increased understanding of PLC injuries, the changes in treatment strategy to early and more aggressive anatomical reconstruction, as well as the remaining controversies in the management and rehabilitation, the purpose of this study was to determine the current worldview of surgeons treating these injuries. Specifically, an online survey was used to determine key concepts on diagnosis, treatment strategy, and rehabilitation options for patients presenting with PLC injuries. It was hypothesized that variability would be observed in surgeon responses for the diagnosis, management, and rehabilitation of PLC injuries. The results will help to determine where current practice differs from evidence-based algorithms.

Materials and methods

Study design and administration

A 12-question multiple-choice online survey was designed and distributed to all members of the following orthopedic national societies: American Orthopedic Society for Sports Medicine (AOSSM), Arthroscopic Association of North America (AANA), European Society of Sports Traumatology, Knee Surgery, and Arthroscopy (ESSKA), Latin American Society of Arthroscopy, Knee and Sports (SLARD), Arthroscopy and Sport Medicine Society (APKASS), Argentinian Arthroscopy Association (AAA), Colombian Arthroscopy Association (ACCART), Spanish Arthroscopy Association (AEA), Australian Knee Society (AKS), Japanise Orthopaedic Society of Knee, Arthroscopy and Sport Medicine (JOSKAS), South African Knee Society (SAKS), Mexican Arthroscopy Association (AMECRA), French Speaking Arthroscopy Society (SFA), Korean Knee Society (KKS), British Association for Surgery of the Knee (BASK), German Knee Society (DKG), Asian-Pacific Knee, German speaking Society for Orthopaedic, Traumatology and Sport Medicine (GOTS), and Swedish Orthopaedic Society (SOS). An online link to the survey was sent to all organization members, including retired and international members. The survey was sent to members once without additional follow-up emails for completion. Information regarding location of training, annual cases performed, favored treatment, technique details, and postoperative care was collected. A complete list of administered questions is displayed in Table 1.

Data analysis

Survey responses were collected through the included organizations online services. Similar to previously published survey studies [1, 17, 27], statistical analyses were not performed. Survey respondents were subsequently split into geographical regions by one researcher to determine differences in the management of PLC injuries between different continents.

Use of clinical agreement

Clinical agreement has been inconsistently defined in the literature. Marx et al. defined clinical agreement as 80% of surgeons answering similarly on a survey [16], and this definition has been utilized in subsequent survey studies [4]. Other definitions of agreement have been proposed, such as Wright et al., defining clinical agreement as > 90% of physicians answering similarly [26] and Tierney et al. defining general agreement as a value > 60% [25]. While our administered survey did not specifically use questions requiring participants to directly respond "Agree" or "Disagree", for the purposes of this study, we defined "clinical agreement" as > 80% agreement in survey response corresponding with

Table 1 Complete list of survey questions administered to participants

Q1	In which region do you work?
Q2	How many PLC procedures do you perform in a calendar year?
Q3	Within what time frame do patients with PLC injuries usually present to you for assessment?
Q4	Which clinical test do you MOST rely on when assessing PLC injuries?
Q5	Which imaging methods do you regularly use to assess for the need for PLC surgery?
Q6	Do you grade PLC injuries according to a classification system when assessing the need for surgery?
Q7	Is surgical repair a reasonable primary procedure in acute PLC injuries other than for bony avulsions?
Q8	What is your preferred surgical technique for PLC reconstruction?
Q9	Which grafts do you prefer to use for PLC reconstruction/augmentation?
Q10	Do you regularly use a post-operative brace following PLC surgery?
Q11	When do you usually allow weight bearing after PLC surgery?
Q12	When do you allow for return to play?

Table 2 Demographic data on survey respondents

Answer choices	Responses (%)
Europe	48.7
North America	20.6
Latin America	12.6
Asia	12.2
Oceania	3.9
Africa	1.7

Table 3 Number of PLC procedures performed by survey respondents

Answer choices	Responses (%)
0–4	61.5
5–9	25.3
10–29	11.2
> 30	2.0

Table 4 Time for PLC injuries to present for assessment

Answer choices	Responses (%)
Mostly acutely—inside 1 week from injury	16.2
Mostly subacutely—between 1 and 4 weeks from injury	46.7
Mostly chronic—after 3 months from injury	15.1
Around half are acute and half are chronic cases	14.0

Marx et al. criteria and "general agreement" as > 60% in accordance with Tierney et al.

Results

Characteristics of participants

Responses were collected from a total of 975 participants. A majority of participants worked in Europe (49%), followed by North America (20.6%), Latin America (12.6%), and Asia (12.2%) (Table 2). Approximately 60% of participants performed less than four PLC procedures in a calendar year, with only 13.2% of participants performing ten or more PLC procedures in a year (Table 3).

Clinical assessment

With regards to the time frame that patients with PLC injuries present for assessment, 46.7% of respondents stated that patients present sub-acutely at approximately 1–4 weeks after injury (Table 4). The dial test was reported to be the most reliable clinical test to assess PLC injuries (56%) followed by the posterolateral drawer test (18.3%) (Table 5). The vast majority of surgeons (97.4%) regularly use MRI to assess symptomatic patients for possible PLC surgery. Standard X-rays and stress X-rays were also reported as routinely used for assessment by 52.4% and 41.9% of surgeons, respectively (Table 6). 42.1% of surgeons reported that they do not use a classification system for PLC injuries when assessing the need for surgery (Table 7). However, 25.6% of surgeons reported utilizing Fanelli's classification for grading PLC injuries and 11.1% of surgeons reported using Hughston's classification.

Table 5 Clinical tests to assess for the presence of PLC injuries

Answer choices	Responses (%)
Dial-test	55.8
Posterolateral drawer	18.3
Valgus stress test	9.0
Instrumented laxity	1.9
External rotation recurvatum	10.8
Reverse pivot shift test	4.2

Table 6 Preferred imaging methods for assessing PLC injuries

Answer choices	Responses (%)
Standard X-rays	52.4
Stress X-rays	41.9
MRI	97.4
Long standing X-ray for leg alignment	31.8
CT scan	3.3
Do not have access to stress radiographs	5.3
Do not have access to long-standing X-ray	2.9
Do not have access to MRI	0.2

MRI magnetic resonance imaging, *CT* computed tomography

Table 7 Use of classification system when grading PLC injuries

Answer choices	Responses (%)
Yes. Fanelli's classification	25.6
Yes. Hughston's classification	11.1
Yes. Other classification	7.0
No. I do not find current classification systems adequate/useful. A new classification system is needed	42.1
No. It is not necessary to classify these injuries	17.2

Surgical intervention and techniques

Approximately 53% of surgeons believe that repair, reconstruction, or as needed augmentation are reasonable primary procedures for acute PLC injuries and should be decided on a case-by-case basis. Roughly 21% of surgeons agree that surgical repair is a reasonable primary procedure as long as it is combined with graft augmentation (Table 8). Regarding graft-type preference, 53% of responders preferred semitendinosus tendon autograft, followed by 16% reporting tibialis anterior or posterior tendon allograft and nearly 14% preferring Achilles tendon allograft (Fig. 1). Approximately 42% of surgeons utilize fibular and tibial tunnels for PLC reconstruction (Fig. 2). Approximately 24% and 28% of surgeons use the fibula-based technique with one femoral tunnel or two femoral tunnels, respectively.

Post-operative management

Post-operatively, roughly 70% of surgeons regularly use a post-operative brace for the first 6 weeks following PLC surgery (Table 9). Regarding weight-bearing restrictions, roughly 55% of surgeons allow partial weight bearing for 2–6 weeks. An equal percent of surgeons (17%) enforced non-weight bearing restrictions for 3 weeks and 6 or more weeks, respectively (Table 10). A majority of surgeons allow for return-to-sport (RTS) between 9 and 12 months after surgery and after specified RTS criteria have been met (Table 11). Approximately 23% of surgeons allow for RTS earlier at roughly 6 months.

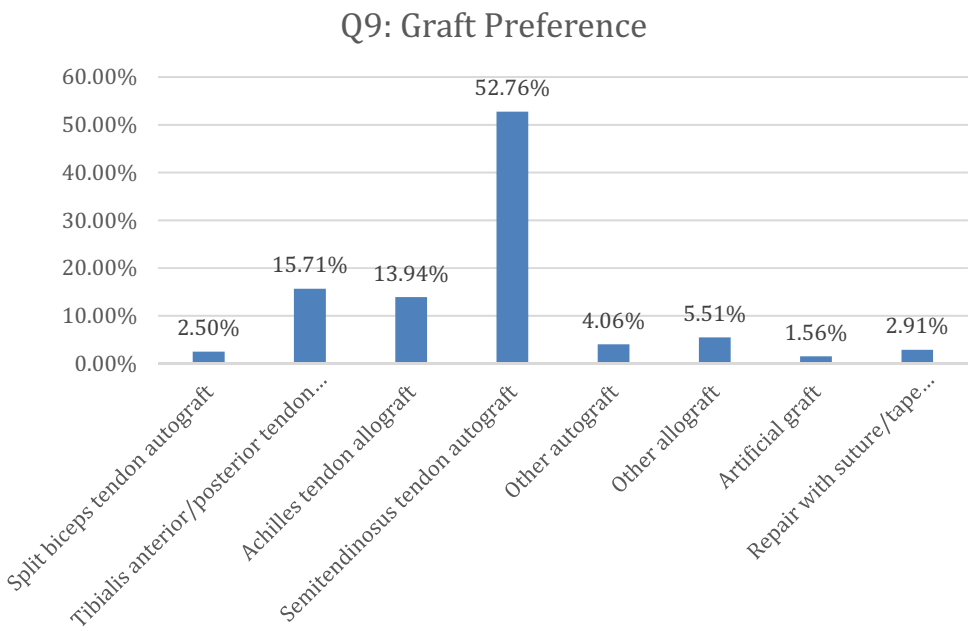
Clinical agreement

Based on the established definitions explained previously, there was clinical agreement regarding the regular use of MRI to assess the need for PLC surgery (97.55%). There was general agreement in specific post-operative management plans, particularly for the use of a brace 6 weeks postoperatively (65.34%). Time to return to play approached general agreement with 57% of surgeons allowing return between 9 and 12 months. Graft preference approached general agreement with 53% of surgeons preferring to use a semitendinosus tendon autograft.

Table 8 Evaluation of surgical repair as a reasonable primary procedure in acute PLC injuries other than for bony avulsions

Answer choices	Responses (%)
Yes, isolated repair is adequate for most cases	7.7
Yes, but only when combined with a graft (auto/allograft) augmentation	21.3
Yes, but only when combined with a suture/tape augmentation	3.1
Depends on the case. Repair, reconstruction, or augmentation as needed	53.4
No. Reconstruction is always needed	14.5

Fig. 1 Graft preference



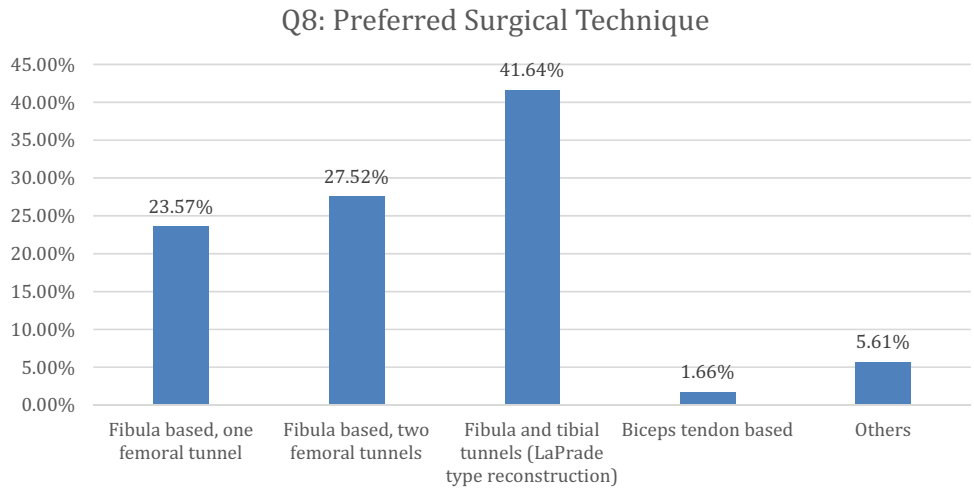


Fig. 2 Preferred surgical technique

Table 9 Use of post-operative brace

Answer choices	Responses (%)
Yes, for the first 6 weeks post-op	69.8
Yes, for longer than 6 weeks	24.3
No, not for isolated posterolateral corner injury unless brace used for management of concomitant injury	3.8
No, I do not think that bracing is useful for this patient group	2.1

Table 10 Weight bearing after surgery

Answer choices	Responses (%)
Immediate full weight bearing	11.2
Partial weight bearing for 3–6 weeks	55.5
Non-weight bearing for around 3 weeks	16.7
Non-weight bearing for around 6 or more weeks	16.6

Results and clinical agreement by region

Survey responses were divided and analyzed by region (continent) to determine differences in regional preferences in PLC management. The complete data can be viewed in Appendix 1. In Europe, North America, Latin America, and Asia, the majority of respondents (56.2–67.8%) treated between 0 and 4 PCL per year, while in Ocean and Africa, fewer respondents treated this number (47.4% and 23.5%). Similar to the global result, the use of MRI in the diagnosis of PLC injuries reached clinical consensus in all regions. Six weeks of post-operative bracing reached clinical or general consensus in all regions other than Asia where 56% of surgeons advised brace use for longer than 6 weeks. No region reached a clinical or general consensus in treatment strategy or preferred surgical technique for PLC injuries. Surgeons in Europe, Latin America, and North America showed a similar breakdown of reconstruction techniques with between 43 and 49% using anatomical-based fibular and tibial reconstruction techniques. This is contrast to Oceania and Asia where 21.5% of respondents used this technique for reconstruction, respectively.

The use of autograft or allograft for PLC reconstruction varied in different regions. Respondents from Europe, Asia, Latin America, and Africa reached general agreement on the

Table 11 Return to play

Answer choices	Responses (%)
After 6 months and return to sport criteria are met	22.9
Between 9 and 12 months and return to sport criteria are met	56.9
Depends on the procedure, repair 3–6 months—reconstruction 6–12 months	13.5
Never—I advise against return to sport	0.7
Return to sport is not time-dependent	6.0

use of semitendinosus autografts for PLC reconstructions. This contrasts to respondents in North America where much fewer number respondents chose a semitendinosus autograft as their preferred graft (17%) A total of 78.2% North American and Oceania respondents used mostly allografts in comparison to the rest of the regions (Table 12).

Discussion

The main findings of this study were that only 13% of surgeons treating these injuries worldwide manage > 10 of these injuries yearly. Also, clinical agreement of > 80% was only evident in the use of MRI in the diagnosis of PLC injury. A general agreement of > 60% was present for the use of a post-operative brace in the early rehabilitation. These results are a good picture on how these injuries are generally treated, as this study presents the largest survey on surgeon preferences towards the diagnosis, treatment, and rehabilitation of PLC injuries. 975 surgeons registered in one of the five major sports medicine and several national associations completed the survey. The respondents represented the global surgical community with 49% from Europe, 21% from North America, 12% from Latin America, 12% from Asia, and smaller percentages from Africa and Oceania.

For the majority of survey questions, a clinical agreement was not met indicating a wide variation in surgeon attitudes in the management of PLC injuries, which confirmed our hypothesis. This contrasts to a recent survey given to 27 international experts in PLC surgery in which clinical agreement of > 80% was reached for the majority of questions in the categories of diagnosis, classification, treatment, and rehabilitation. A possible reason for the higher heterogeneity within our study is the majority of surgeons surveyed treat between 1 and 4 PLC injuries a year and only 13% treat more than 10. This held true in all regions other than Africa. This shows that while treatment strategies for the previously termed "dark side of the knee" are becoming algorithmic in the expert community, this has not translated yet to the larger surgical community. This low number of PLC injuries treated per year by most surgeons' contrasts to the proposed incidence of PLC injuries of around 9% of all acute ligamentous knee injuries [13]. In a retrospective study examining the incidence of injury to at least one PLC structure in patients with ACL ruptures, Temponi et al. determined the incidence to be 19.1% [24]. While documentation of injury on MRI does not correlate directly to clinical significance, the low number treated by the majority of respondents indicates that either these injuries are being diagnosed and referred to high-volume multi-ligament surgeons or that they continue to be under-diagnosed. It is well known that missed high-grade PLC injuries lead to both patient functional limitations and a higher rate of cruciate ligament reconstruction graft failures [12, 21].

While most PLC injuries were reported to present to surgeons within a 1–4-week window, a high number (15.1%) reported most injuries present chronically at around 3 months. Results for PLC injuries are best when treated within a 3-week window providing a return of full range of motion [2, 5]. This finding shows that despite the recent attention to the PLC in the literature, these injuries continue to be under diagnosed acutely and present chronically. Nearly all respondents, in all regions, use MRI routinely in the diagnostic work-up of PLC injuries; however, only 41.9% regularly obtain stress X-rays to aid in decision-making. Varus stress X-rays have been shown to be a useful tool in the evaluation of the extent of a suspected lateral-sided knee injury. LaPrade et al. demonstrated that an increase of 2.7 mm of lateral compartment gapping from the intact state is consistent with an isolated, grade III tear of the fibular collateral ligament (FCL) [11]. A difference of 4.0 mm was consistent with a complete posterior collateral ligament (PCL) injury. More recent literature supports even lower side-to-side differences in grade 3 FCL tears [7, 19]. Expert consensus had a 75% agreement rate that these radiographs should be part of routine assessment and decision-making [3].

No single treatment strategy reached clinical or general consensus. When splitting respondents by region, there was still similar variability in treatment strategy. Acute repair was the preferred treatment choice in 8% of surgeons and 53% believe that repair, reconstruction, or as needed augmentation are reasonable primary procedures and case-by-case dependent. Only 15% would reconstruct in all cases. This contrasts the expert consensus statement that reconstruction of all injured structures is the preferred approach [3]. Stannard et al. reported a 37% failure rate after PLC repair versus 9% in the reconstruction group [23]. In a similar study by Levy et al., a 40% failure rate was reported in the repair group versus 6% in the reconstruction group [15]. Similar results were observed in a systematic review of management of acute PLC injuries [6]. As such, the high use of isolated repair observed in the current survey contradicts the findings most prevalent in the literature that the isolated repair of the

Table 12 Autograft versus allograft preference by region

	Europe (%)	North America (%)	Latin America (%)	Asia (%)	Africa (%)	Oceania (%)
Allograft	24.6	78.2	26.8	12.9	5.9	73.7
Autograft	69.1	17.0	66.7	82.1	88.3	23.7

PLC injuries should be cautioned with the exception of specific ligament avulsions. Geeslin and LaPrade showed that acute repair of PLC structures in specific cases of avulsion fractures with evidence of ligamentous stretching can achieve good outcomes [5]. However, for the most part, overall, the pendulum has swung towards reconstructions in most cases of PLC injuries, both acute and chronic.

Reconstruction techniques used were also variable with 42% of surgeons using an anatomically based reconstruction technique with both fibular and tibial tunnels. This is similar to the findings of a systematic review on PLC outcomes performed by Moulton et al. [20]. In this review, the use of a variety of anatomical and also non-anatomical surgical techniques was reported despite the inclusion of only high-volume surgeons. In the current survey, 50% of respondents used primarily techniques based on isometric principles of single fibular head tunnel and one or two femoral tunnels as previously described by Larsen et al. and subsequently modified by numerous authors [14, 22]. Anatomical reconstruction pioneered by LaPrade has demonstrated restoration of the native knee biomechanics and good short-term clinical outcomes [10, 18]. While there is no clear consensus in the literature regarding the optimal reconstruction technique, 92% of experts agreed that anatomically based reconstruction of each injured structure should be attempted [3]. Interestingly, the percentage of surgeons utilizing single-graft fibular-based techniques correlated with the 53% of respondents opting for semitendinosus autograft as their preferred graft for reconstructions. This single autograft would likely be insufficient for a two-graft anatomical reconstruction of the PLC. It is possible that the difficulty of obtaining adequate allograft tissue in many regions of the world limits the use of the anatomical technique in PLC reconstructions. However, the number of anatomic reconstructions in Europe and Latin America was similar to those in North America despite the infrequent use of allograft tissue in these two regions compared to North America.

There was less variability in rehabilitation protocols with general consensus reached on use of a brace for 6 weeks and general consensus approached for return to sport at 9–12 months post-operatively. Most surgeons limited or completely restricted weight-bearing for up to 6 weeks. LaPrade et al. showed that randomization to partial weight-bearing or non-weight-bearing after FCL reconstruction with or without ACL reconstruction had similar clinical outcomes [9]. Given that PLC injuries rarely occur in isolation, it is expected that rehabilitation protocols exhibit variability given the associated soft tissue and osseous injuries; however, this study shows that most surgeons take an overall conservative approach.

The strength of this study lies in the high number of respondents of the survey representing an international demographic. Such evaluation among different areas has not been previously performed. It offers a better understanding on how the PLC is approached differently depending on geographical areas. The limitation of the study was that the data obtained from the survey were pooled and we were unable to correlate different practice habits to certain regions or high- or low-volume surgeons. Another limitation of the methodology is that the complexities of clinical decision-making for PLC were simplified by the survey questions. There is significant heterogeneity in these injuries, in terms of the number of structures injured and the concomitant bony and soft-tissue injuries that can be present that can change treatment and rehabilitation practices. Despite these limitations, this study demonstrates that global clinical consensus for PLC remains elusive. Collaboration among societies will be needed moving forward for the dissemination of evidence-based treatment algorithms and for further research to create clinically useful practice guidelines for PLC injuries.

Conclusion

Despite the high level of consensus seen in a recent expert statement on PLC injuries, there remains a significant variability in the diagnosis, treatment, and postoperative management of these injuries. The number of PLC injuries treated yearly by most surgeons remains low.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

References

1. Brunton LM, Wilgis EFS (2010) A survey to determine current practice patterns in the surgical treatment of advanced thumb carpometacarpal osteoarthrosis. Hand 5:415–422
2. Chahla J, Moatshe G, Dean CS, LaPrade RF (2016) Posterolateral corner of the knee: current concepts. Arch Bone Joint Surg 4:97–103
3. Chahla J, Murray IR, Robinson J et al (2019) Posterolateral corner of the knee: an expert consensus statement on diagnosis, classification, treatment, and rehabilitation. Knee Surg Sports Traumatol Arthrosc 27:2520–2529
4. Dunn WR, Schackman BR, Walsh C et al (2005) Variation in orthopaedic surgeons' perceptions about the indications for rotator cuff surgery. J Bone Joint Surg 87:1978–1984
5. Geeslin AG, LaPrade RF (2011) Outcomes of treatment of acute grade-III isolated and combined posterolateral knee injuries: a

prospective case series and surgical technique. J Bone Joint Surg Am 93(18):1672–1683
6. Geeslin AG, Moulton SG, LaPrade RF (2016) A systematic review of the outcomes of posterolateral corner knee injuries, part 1: surgical treatment of acute injuries. Am J Sports Med 44:1336–1342
7. Kane PW, Cinque ME, Moatshe G et al (2018) Fibular collateral ligament: varus stress radiographic analysis using 3 different clinical techniques. Orthop J Sports Med 6:2325967118770170
8. Kannus P (1989) Nonoperative treatment of grade II and III sprains of the lateral ligament compartment of the knee. Am J Sports Med 17:83–88
9. LaPrade RF, DePhillipo NN, Cram TR et al (2018) Partial controlled early postoperative weightbearing versus nonweightbearing after reconstruction of the fibular (lateral) collateral ligament: a randomized controlled trial and equivalence analysis. Am J Sports Med 46:2355–2365
10. Laprade RF, Griffith CJ, Coobs BR, Geeslin AG, Johansen S, Engebretsen L (2014) Improving outcomes for posterolateral knee injuries. J Orthop Res 32:485–491
11. LaPrade RF, Heikes C, Bakker AJ, Jakobsen RB (2008) The reproducibility and repeatability of varus stress radiographs in the assessment of isolated fibular collateral ligament and grade-III posterolateral knee injuries. An in vitro biomechanical study. J Bone Joint Surg Am 90:2069–2076
12. LaPrade RF, Muench C, Wentorf F, Lewis JL (2002) The effect of injury to the posterolateral structures of the knee on force in a posterior cruciate ligament graft: a biomechanical study. Am J Sports Med 30:233–238
13. LaPrade RF, Wentorf FA, Fritts H, Gundry C, Hightower CD (2007) A prospective magnetic resonance imaging study of the incidence of posterolateral and multiple ligament injuries in acute knee injuries presenting with a hemarthrosis. Arthroscopy 23:1341–1347
14. Larsen MW, Moinfar AR, Moorman CT 3rd (2005) Posterolateral corner reconstruction: fibular-based technique. J Knee Surg 18:163–166
15. Levy BA, Dajani KA, Morgan JA, Shah JP, Dahm DL, Stuart MJ (2010) Repair versus reconstruction of the fibular collateral ligament and posterolateral corner in the multiligament-injured knee. Am J Sports Med 38:804–809
16. Marx RG, Jones EC, Angel M, Wickiewicz TL, Warren RF (2003) Beliefs and attitudes of members of the American Academy of orthopaedic surgeons regarding the treatment of anterior cruciate ligament injury. Arthroscopy 19:762–770
17. Mathes DW, Schlenker R, Ploplys E, Vedder N (2009) A survey of North American hand surgeons on their current attitudes toward hand transplantation. J Hand Surg Am 34:808–814.e802
18. McCarthy M, Camarda L, Wijdicks CA, Johansen S, Engebretsen L, Laprade RF (2010) Anatomic posterolateral knee reconstructions require a popliteofibular ligament reconstruction through a tibial tunnel. Am J Sports Med 38:1674–1681
19. McDonald LS, Waltz RA, Carney JR et al (2016) Validation of varus stress radiographs for anterior cruciate ligament and posterolateral corner knee injuries: a biomechanical study. Knee 23:1064–1068
20. Moulton SG, Geeslin AG, LaPrade RF (2016) A systematic review of the outcomes of posterolateral corner knee injuries, Part 2 surgical treatment of chronic injuries. Am J Sports Med 44:1616–1623
21. Ranawat A, Baker CL 3rd, Henry S, Harner CD (2008) Posterolateral corner injury of the knee: evaluation and management. J Am Acad Orthop Surg 16:506–518
22. Shi SY, Ying XZ, Zheng Q, Cao GP (2009) Isometric reconstruction of the posterolateral corner of the knee. Acta Orthop Belg 75:504–511
23. Stannard JP, Brown SL, Farris RC, McGwin G Jr, Volgas DA (2005) The posterolateral corner of the knee: repair versus reconstruction. Am J Sports Med 33:881–888
24. Temponi EF, de Carvalho Junior LH, Saithna A, Thaunat M, Sonnery-Cottet B (2017) Incidence and MRI characterization of the spectrum of posterolateral corner injuries occurring in association with ACL rupture. Skelet Radiol 46:1063–1070
25. Tierney WM, Fitzgerald JF, Heck DA et al (1994) Tricompartmental knee replacement. A comparison of orthopaedic surgeons' self reported performance rates with surgical indications, contraindications, and expected outcomes. Knee Replacement Patient Outcomes Research Team. Clin Orthop Relat Res 305:209–217
26. Wright JG, Coyte P, Hawker G et al (1995) Variation in orthopedic surgeons' perceptions of the indications for and outcomes of knee replacement. CMAJ 152:687–697
27. Zarkadas PC, Gropper PT, White NJ, Perey BH (2004) A survey of the surgical management of acute and chronic scapholunate instability. J Hand Sur Am 29:848–857

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