



Original article

Posterior cruciate ligament injury: characteristics and associations of most frequent injuries^{☆,☆☆}

Marco Túlio Lopes Caldas^{a,*}, Gilberto Ferreira Braga^b, Samuel Lopes Mendes^c,
Juliano Martins da Silveira^d, Robson Massi Kopke^d

^a Orthopedist and Traumatologist; Head of the Medical Residence Service of Hospital Maria Amélia Lins, Fundação Hospitalar do Estado de Minas Gerais (FHEMIG); Member of the Knee Group of Hospital Maria Amélia Lins, FHEMIG, Belo Horizonte, MG, Brazil

^b Preceptor of Medical Residence in Orthopedics and Traumatology, Hospital Maria Amélia Lins, FHEMIG, Belo Horizonte, MG, Brazil

^c Resident Physician (R4) in Knee Orthopedics at Hospital Maria Amélia Lins, FHEMIG, Belo Horizonte, MG, Brazil

^d Resident Physician (R4) in Knee Orthopedics at the Ortolife Clinic, Belo Horizonte, MG, Brazil

ARTICLE INFO

Article history:

Received 1 July 2012

Accepted 3 September 2012

Keywords:

Retrospective studies

Knee

Posterior cruciate ligament/injuries

Posterior cruciate ligament/surgery

ABSTRACT

Objective: To investigate the prevalence and combinations of PCL injuries and their correlations with the mechanism, the occurrence of evident dislocation and associated fracture.

Method: A retrospective study of 85 lesions of PCL operated between 2003 and 2010. Diagnosis by physical examination and dynamic radiography, compared with surgical findings.

Results: Injuries involving the PCL were more prevalent in men (78.8%) with a mean age of 33 years. The main cause was traffic accidents (73.80%), and (49.4%) motorcycle. Isolated PCL injury occurred in (15.3%) cases, and combined (84.7%). Among the isolated lesions, bone avulsions were nine (10.6%). The most associated PCL injuries were the ACL (48.2%), followed by LCL PCL/PLC (22.4%). Fractures were more associated with combining PCL + LCL/PLC injuries and did not appear in the PCL + MCL/PMC. Complications beyond fractures: peripheral nerve injury (4.8%) and vascular (1.2%). Evident dislocation in primary care (16.7%) was more prevalent in combined ACL + PCL + MCL/PMC (44.4%). Half the patients were operated during the acute phase. There was a statistically significant difference ($p < 0.05$) comparing each combination of ligament injuries with the presence of fracture, dislocation or clear mechanism of injury.

Conclusion: Surgical treatment of PCL injuries in a center for orthopedic trauma care was mostly multiligament and mainly involving the ACL. A significant association was seen between the type of injury with mechanism of injury, presentation of the knee, if dislocated or reduced, and the presence of associated fracture.

© 2013 Sociedade Brasileira de Ortopedia e Traumatologia. Published by Elsevier Editora Ltda. Este é um artigo Open Access sob a licença de [CC BY-NC-ND](http://creativecommons.org/licenses/by-nc-nd/4.0/)

[☆] Please cite this article as: Caldas MTL, Braga GF, Mendes SL, da Silveira JM, Kopke RM. Lesões do ligamento cruzado posterior: características e associações mais frequentes. Rev Bras Ortop. 2013;48:427-431.

^{☆☆} Study conducted at the Hospital Maria Amélia Lins, Fundação Hospitalar do Estado de Minas Gerais, Belo Horizonte, MG, Brazil.

* Corresponding author at: Rua Flavita Bretas, 29/901, Luxemburgo, Belo Horizonte, CEP 30380410 MG, Brazil.

E-mail: mtuliolc@gmail.com (M.T.L. Caldas).

2255-4971 © 2013 Sociedade Brasileira de Ortopedia e Traumatologia. Published by Elsevier Editora Ltda.

Este é um artigo Open Access sob a licença de [CC BY-NC-ND](http://creativecommons.org/licenses/by-nc-nd/4.0/) <http://dx.doi.org/10.1016/j.rboe.2012.09.010>

Lesões do ligamento cruzado posterior: características e associações mais frequentes

R E S U M O

Palavras-chave:
Estudos retrospectivos
Joelho
Ligamento cruzado posterior/lesões
Ligamento cruzado posterior/cirurgia

Objetivo: Pesquisar a prevalência das lesões do ligamento cruzado posterior (LCP) e suas combinações e correlações com o mecanismo e a ocorrência de luxação evidente e fratura associada.

Método: Estudo retrospectivo de 85 lesões do LCP operadas entre 2003 e 2010. Diagnóstico por meio do exame físico e da radiografia dinâmica, confrontados com achados cirúrgicos.

Resultados: Lesões que envolveram o LCP foram mais prevalentes nos homens (78,8%) com média de idade de 33 anos. A causa principal foi o acidente de trânsito (73,80%), dos quais 49,4% de motocicleta. Lesão isolada do LCP ocorreu em 15,3% dos casos e combinada em 84,7%. Dentre as lesões isoladas, nove foram avulsões ósseas (10,6%). O ligamento mais associado às lesões do LCP foi o cruzado anterior (48,2%), seguido da lesão combinada do LCP com o ligamento colateral lateral/canto póstero-lateral (22,4%). Fraturas estiveram mais associadas à combinação LCP+LCL/CPL e não apareceram nas lesões do LCP+ligamento colateral medial/canto póstero-medial. Complicações além de fraturas: lesão de nervo periférico (4,8%) e vascular (1,2%). Luxação evidente no primeiro atendimento (16,7%), mais prevalente na combinação LCP+LCA+LCM/CPM (44,4%). Metade dos pacientes foi operada na fase aguda. Houve diferença estatística significativa ($p < 0,05$) na comparação de cada combinação de lesões de ligamentos com a presença de fratura, luxação evidente ou mecanismo do trauma.

Conclusão: Lesões do LCP submetidas a tratamento cirúrgico em centro de atenção ao trauma ortopédico foram na sua maioria multiligamentares e envolveram principalmente o LCA. Houve associação significativa entre o tipo de lesão com o mecanismo de trauma, a forma de apresentação do joelho, se luxado ou reduzido, e a presença de fratura associada.

© 2013 Sociedade Brasileira de Ortopedia e Traumatologia. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob a licença de [CC BY-NC-ND](#)

Introduction

With the explosive increase in the number of vehicles, especially motorcycles, lower-limb injuries and particularly knee injuries have become public health problems. They have high social and economic costs. Improvements in diagnosis and advances in knowledge of anatomy, biomechanics and surgical techniques have increased the interest in studies involving the posterior cruciate ligament (PCL).¹⁻⁶ Large number of PCL injuries are caused by high-energy trauma, and in these cases, knee injury may be difficult particularly when patients present fractures of the ipsilateral femur and/or tibia. In evaluating these patients, just as in multiple trauma cases, ligament injuries may go unnoticed at the initial attendance.^{7,8} Few studies have evaluated different combinations of injuries that involve the PCL, in relation to the mechanism, incidence of fractures in the knee affected or evident dislocation. Studying these characteristics may contribute toward making a correct diagnosis during the acute phase and enabling appropriate treatment at the ideal time.

The objective of this study was to investigate the prevalence of combined injuries of the PCL and their correlations with the mechanism, occurrences of evident dislocation and associated fractures.

Materials and methods

By consulting our institution's surgical records, we surveyed the medical files of patients who underwent surgical treatment for PCL injuries of the knee between May 2003 and September 2010 and found 85 cases in 84 patients. We investigated the trauma mechanism, the number of ligaments injured, the prevalence of different combinations of injuries and the association of each of them with knee fractures, evident dislocation, trauma mechanism and time elapsed between the accident and the definitive treatment. In the institution where the study was conducted, the diagnoses made in the emergency sector was compared with the diagnoses that residents undergoing specialization training within the Knee Surgery Group made by means of history-taking, physical examination and radiographs. Afterwards, the diagnoses were reviewed by knee surgeons, who made physical and radiological examinations of stress (dynamic examinations), under anesthesia during the immediate preoperative period. The diagnosis was complemented by the surgical findings from the cases operated during the acute phase.

Descriptive analysis was performed on the study variables, using frequency tables and central trend/position and variability measurements, and inferential analysis was conducted in order to assess factors associated with the injuries.

Table 1 – Frequencies of injured ligaments and trauma mechanism.

	Frequency	Percentage
<i>Number of ligaments injured</i>		
1	12	14.1
2	37	43.5
3	35	41.2
4	1	1.2
<i>Trauma mechanism</i>		
Motorcycle	42	49.4
Being run over	17	20.0
Sprain	12	14.1
Car collision	8	9.4
Fall from height or martial arts	3	3.5

Table 2 – Frequency of associated injuries, evident dislocation and PCL bone avulsion.

	Frequency	Percentage
Fracture ^a	17	20.5
Peripheral nerve injury ^b	4	4.8
Vascular injury ^b	1	1.2
Evident dislocation ^b	14	16.7
PCL bone avulsion	9	10.6

^a Two cases without information (2.4%).

^b One case without information (1.2%).

Pearson's chi-square test was also used, in order to compare proportions, and Fisher's exact test for small samples. For numerical variables, the nonparametric Mann-Whitney test or the Kruskal-Wallis test was used, because of the asymmetrical nature of the variables tested. The significance level was taken to be 5%. The SPSS 15.0 software was used.

Results

The incidence of PCL injuries was greater among the men (78.8%). The mean age was 32.9 years, with a standard deviation of 11.9. Most of the cases presented two (43.5%) or three (41.2%) injured ligaments. The prevalence of PCL injury alone was 15.3%. Nine (10.6%) of the injuries were due to bone avulsion. Traffic accidents were responsible for 73.8% of the injuries and of these, the most frequent trauma mechanism (49.4%) was motorcycle accidents, followed by being run over (20%) (Table 1).

Table 2 shows the frequencies of associated injuries, evident dislocation and PCL avulsion.

PCL injuries combined with other ligaments accounted for 84.7% of the cases, and of these, the largest number involved the anterior cruciate ligament (ACL) (48.2%), followed by the lateral collateral ligament/posterolateral corner (LCL/PLC) (22.4%). The prevalence of injuries to both cruciate ligaments without combination with peripheral ligaments or with evident dislocation was 7.1%. In analyzing the relationship of each injury combination with the cause, motorcycle accidents were the most frequent cause, with a statistically significant difference (p -value < 0.05), except for patients with the combination of PCL + medial collateral ligament/posteromedial

corner (MCL/PMC), for whom being run over was the most frequent mechanism (41.7%) (Table 3).

There was a significant difference ($p < 0.012$) in comparing the different combinations of ligament injuries with occurrences of fractures or presentation of evident dislocation at the emergency service ($p < 0.007$). Fractures were more associated with the combinations PCL + LCL/PLC (38.9%) and PCL/ACL + LCL/PLC (37.5%), while evident dislocation was more associated with the combination PCL/ACL + MCL/PMC (44.4%) (Table 4).

In 85% of the cases, the knee ligaments were operated within the first eight months, and 50% of these operations were performed in the acute phase, up to three weeks after the injury.

Discussion

In this study, 85 PCL injuries were evaluated, in patients who underwent surgical treatment in an orthopedic trauma care center between May 2003 and December 2010. The diagnosis was done by means of clinical examination, with dynamic assessment of the knee under anesthesia, and was complemented by the surgical findings in the cases operated in the acute phase. With regard to gender, the relationship consisted of approximately four men for every woman, and the greatest incidence was in the third decade of life, i.e. similar to reports in the literature.^{9,10}

Fanelli et al.^{11,12} reported that the incidence of PCL injury was 44% in a tertiary-level trauma care center, among knees with hemarthrosis that underwent examination under anesthesia and arthroscopy. The main causes were high-energy trauma (81.5%) and sports injuries (18%). PCL injury alone occurred in 7.5% and combinations with other ligament injuries in 92.5%. La Prade¹³ assessed knee ligament injuries and observed that PCL rupture occurred in 14.4% of the cases, and in 8.2% of the patients with hemarthrosis after acute trauma.

Acute-phase knee ligament injuries are diagnosed by means of taking a detailed history, making a careful physical examination and producing stress radiographs under anesthesia. Magnetic resonance imaging is considered to be the gold standard.¹³⁻¹⁷ In some cases, the ligament injury is not diagnosed because the symptoms may remain masked when, for example, ipsilateral fractures occur, as reported by Braga et al.¹⁸ In their study, 28 patients with 29 unstable femoral fractures were treated with locking intramedullary nails and were evaluated in the immediate postoperative period with the aim of determining the incidence of associated ligament injuries. Eight patients (28.6%) presented nine knee ligament injuries (32.1%; one bilateral case). None of these injuries had been reported at the emergency service. In the same study, there was a statistically significant association between complex knee injury and being run over ($p = 0.004$). These authors emphasized that the knees of patients with ipsilateral femoral fractures caused by high-impact injury should be routinely examined.

Studies that have evaluated clinical examinations for diagnosing PCL injuries have found varying degrees of accuracy (96%), specificity (99%) and sensitivity (90%). The latter ranged

Table 3 – Types of injury combinations versus occurrences of fractures or evident dislocation.

PCL alone	PCL + LCL/PLC	PCL + MCL/PMC	PCL/ACL + LCL/PLC	PCL/ACL + MCL/PMC	p-Value
Fracture					
2	7	0	6	1	0.012 ^a
16.7%	38.9%	0%	37.5%	5.6%	
Evident dislocation					
0	3	0	3	8	0.007 ^b
0%	16.7%	0%	18.8%	44.4%	

^a Pearson's chi-square test.
^b Fisher's test.

from 70% for grade I injuries to 97% for grades II and III.¹⁹ Results from clinical examinations and dynamic radiographs should be compared with magnetic resonance imaging (MRI).²⁰ Unfortunately, few hospitals within the Brazilian setting provide access to MRI in the emergency sector. Thus, it is important to have studies that analyze the results from assessments on acute ligament injuries based on dynamic physical and radiological examination under anesthesia.

In the present series, it was found that 78.8% of the injuries were from traffic accidents, of which 49.4% were motorcycle accidents. These results were close to those of Fanelli,¹ who found that 81.5% of their cases resulted from high-energy trauma. Schulz et al.⁹ studied 494 patients and reported that the commonest causes were traffic accidents (45%) and sports injuries (40%), and that motorcycle accidents (28%) and soccer injuries (25%) were the commonest specific causes.

Identifying different types of knee ligament injury is important for the prognosis and for defining the treatment. PCL injury alone has low incidence (7.5%) and those of grades I and II have greater chance of healing, in the same way as medial collateral ligament (MCL) injuries.^{20,21} PCL injuries alone may be asymptomatic, as reported by Parolie and Bergfeld,²¹ who found that the incidence of this characteristic was 2% among players in the American National Football League (NFL). In our series, we found that the incidence of PCL injuries alone was 15.3% and that 69.2% of them were due to bone avulsion. All of these cases underwent surgical treatment.

There is controversy regarding the best treatment for grade III PCL injuries that occur in isolation and for those that are combined with medial or peripheral ligaments.³⁻⁵ In the

present series, surgical treatment was indicated for complete PCL injury (grade III) or for combined injury when the posterior displacement of the tibia was >10 mm.^{8,19} In concordance with a report in the literature,⁵ surgery was the treatment indicated for injuries that involved the PCL or PCL/ACL combined with lateral structures. Hammoud et al.²² conducted a review study on 21 case series of PCL injury alone and 10 of combined injuries. They concluded that there was no evidence regarding the best treatment or the best surgical technique to choose, and that despite the reports of good results following PCL reconstruction, evaluations with longer follow-up suggested that in most cases, normal knee stability was not restored.

Our series included only the cases that underwent surgical treatment in which the main injury mechanism was high-energy trauma. This characteristic may explain the high number of cases involving two or more ligaments (85.9% of the cases). In concordance with other studies, PCL injury appeared in greatest number involving the ACL, i.e. as injuries of both cruciate ligaments, or in combination with medial or lateral peripheral ligaments.^{10,19}

There was a statistically significant difference in comparing the combinations of ligament injuries with the prevalence of fractures or evident dislocation. Associations with fractures were more common in combinations between the PCL and lateral peripheral ligaments. Evident dislocation was more associated with the combination of PCL/ACL with lateral peripheral ligaments and did not occur in cases of PCL injury alone or in combinations between the PCL and medial peripheral ligaments. The prevalence of fractures or bone avulsions

Table 4 – Comparison of types of injury combinations versus mechanism.

	PCL alone	PCL + LCL/PLC	PCL + MCL/PMC	PCL/ACL + LCL/PLC	PCL/ACL + MCL/PMC	p-Value
Trauma mechanism						
Being run over	0	2	5	3	6	0.022 ^a
	0%	11.8%	41.7%	18.8%	35.3%	
Car	2	1	0	2	2	11.8%
	15.4%	5.9%	0%	12.5%	11.8%	
Sprain	0	2	2	5	1	5.9%
	0%	11.8%	16.7%	31.3%	5.9%	
Motorcycle	11	12	3	6	7	41.2%
	84.6%	70.6%	25.0%	37.5%	41.2%	
Others	0	0	2	0	1	5.9%
	0%	0%	16.7%	0%	5.9%	

^a Pearson's chi-square test.

was 20.5%. Injury to both cruciate ligaments (ACL/PCL) without combination with medial or lateral peripheral ligaments and without association with evident dislocation appeared in 7.1% of the cases. This was much lower than what was reported by Lustig et al.²³ who found this combination in 25% of the cases in a multicenter study by the French Society of Orthopedics and Traumatology. It was observed that these authors divided the complex multi-ligament injuries into those affecting both cruciate ligaments (25.4%) and those with classical traumatic dislocation (74.6%). They used epidemiological criteria such as age, presence of associated injuries and type of injury in order to indicate or not indicate surgical treatment. They chose to reconstruct the PCL during the acute phase, in patients under the age of 60 years without associated vascular injuries or exposed dislocation, when the posterior drawer was greater than 10 mm and/or the frontal, medial or lateral opening was greater than 15 mm. They did not indicate ACL reconstruction in the acute phase.

In the series evaluated in our study, only one case was referred with a report of popliteal artery injury. It was also seen that there was low prevalence (4.8%) of common fibular nerve injury, compared with other studies.^{6,24}

In 85% of the cases, the patients were operated within eight months, and 50% of these were operated within the first three weeks, i.e. during the acute phase. The greatest median time between the injury and the surgery (105 days) occurred among patients with PCL + LCL/PLC injuries and the smallest time (8.5 days) among those with PCL injury alone due to bone avulsion. Severe injuries such as those of the PCL + LCL/PLC were operated later on in some cases, which is contrary to the ideal management of giving priority to earlier surgical treatment for this combination of injuries. In the institution where the study was conducted, multiple trauma patients who have undergone damage control are often received, and this also often postpones the definitive treatment for the ligament injury. In series such as that of Schulz et al.⁹ the knee specialists only received 10.3% of the patients within the first 30 days after the injury. Surgery was performed after a mean time period of 44.4 months.

The criterion of only including patients who underwent surgical treatment involving the PCL was an attempt to create a group that would be more homogenous in terms of cause and effect. However, in a study on knee dislocation, Bui et al.²⁰ found that trauma that was considered to be low-energy was the mechanism in 15 cases (75%), such as amateur sports or simple falls, and that only 20% were due to high-energy trauma, such as car accidents.

The number of 85 cases studied seems to have been statistically adequate, given the relatively low incidence of PCL injuries in the general population. In the data analysis, considering the large number of combined injuries, some with very low prevalence, statistical analysis for small samples was used.

Conclusion

The PCL injuries that underwent surgical treatment in this orthopedic trauma center were mostly accompanied by multi-ligament injuries. The most prevalent trauma mechanism was

traffic accidents, notably with involvement of motorcycles and affecting male individuals. The ACL was the ligament most frequently injured in association with the PCL, followed by lateral peripheral injury. There was a significant association between the type of injury and the trauma mechanism, form of knee presentation (dislocated or reduced) and presence of associated fractures.

Conflicts of interest

The authors declare that there were no conflicts of interest.

REFERENCES

1. Fanelli GC, Beck JD, Edson CJ. Current concepts review: the posterior cruciate ligament. *Knee Surg.* 2010;23:61-72.
2. Harner CD, Hoher J. Evaluation and treatment of posterior cruciate ligament injuries. *Am J Sports Med.* 1998;26:471-82.
3. Shelbourne KD, Jennings RW, Vahey TN. Magnetic resonance imaging of posterior cruciate ligament injuries: assessment of healing. *Am J Knee Surg.* 1999;12:209-13.
4. Hermans S, Corten K, Bellemans J. Long-term results of isolated anterolateral bundle reconstructions of the posterior cruciate ligament a 6- to 12-year follow-up study. *Am J Sports Med.* 2009;37:1499-507.
5. Allen CR, Kaplan LD, Fluhme DJ, Harner CD. Posterior cruciate ligament injuries. *Curr Opin Rheumatol.* 2002;14:142-9.
6. McDonough EB, Wojtys EM. Multiligamentous injuries of the knee and associated vascular injuries. *Am J Sports Med.* 2009;37:156-9.
7. Dickson KF, Galland MW, Barrack RL, Neitzschman HR, Harris MB, Myers L, et al. Magnetic resonance imaging of the knee after ipsilateral femur fracture. *J Orthop Trauma.* 2002;16:567-71.
8. Walker DM, Kennedy JC. Occult knee ligament injuries associated with femoral shaft fractures. *Am J Sports Med.* 1980;8:172-4.
9. Schulz MS, Russe K, Weiler A, Eichhorn HJ, Strobel MJ. Epidemiology of posterior cruciate ligament injuries. *Arch Orthop Trauma Surg.* 2003;123:186-91.
10. Camargo OPA, Chamecki A, Lemos PEG, Pecora RAM. Lesão do ligamento cruzado posterior – Incidência e tratamento. *Rev Bras Ortop.* 1996;31:491-6.
11. Fanelli GC. Posterior cruciate ligament injuries in trauma patients. *Arthroscopy.* 1993;9:291-4.
12. Fanelli GC, Edson CJ. Posterior cruciate ligament injuries in trauma patients: part II. *Arthroscopy.* 1995;11:526-9.
13. La Prade RF, Wentorf FA, Fritts H, Gundry C, Hightower CD. A prospective magnetic resonance imaging study of the incidence of posterolateral and multiple ligament injuries in acute knee injuries presenting with a hemarthrosis. *Arthroscopy.* 2007;23:1341-7.
14. Fischer SP, Fox JM, Del Pizzo W, Friedman MJ, Snyder SJ, Ferkel RD. Accuracy of diagnoses from magnetic resonance imaging of the knee: a multi-center analysis of one thousand and fourteen patients. *J Bone Joint Surg Am.* 1991;73:2-10.
15. Margheritini F, Mancini L, Mauro CS, Mariani PP. Stress radiography for quantifying posterior cruciate ligament deficiency. *Arthroscopy.* 2003;19:706-11.
16. Mariani PP, Margheritini F, Christel P, Bellelli A. Evaluation of posterior cruciate ligament healing: a study using magnetic resonance imaging and stress radiography. *Arthroscopy.* 2005;21:1354-61.
17. Clancy WG, Sutherland TB. Combined posterior cruciate ligament injuries. *Clin Sports Med.* 1994;13:629-47.
18. Braga GF, Cunha FM, Lazaroni AP. Instabilidade do joelho associada a fratura do fêmur. *Rev Bras Ortop.* 1999;34:329-32.
19. Rubinstein RA, Shelbourne KD, McCarroll JR, Van Meter CD, Rettig AC. The accuracy of the clinical examination in the setting of posterior cruciate ligament injuries. *Am J Sports Med.* 1994;22:550-7.
20. Bui KL, Ilaslan H, Parker RD, Sundaram. Knee dislocations: a magnetic resonance imaging study correlated with clinical and operative findings. *Skeletal Radiol.* 2008;37, 653-61M.
21. Parolie JM, Bergfeld JA. Long-term results of nonoperative treatment of isolated posterior cruciate ligament injuries in the athlete. *Am J Sports Med.* 1986;14:35-8.
22. Hammoud S, Reinhardt KR, Marx RG. Outcomes of posterior cruciate ligament treatment: a review of the evidence. *Sports Med Arthrosc.* 2010;18:280-91.
23. Lustig S, Leray E, Boisrenoult P, Trojani C, Laffargue P, Saragaglia D, et al. Dislocation and bicruciate lesions of the knee: epidemiology and acute stage assessment in a prospective series. *Orthop Traumatol Surg Res.* 2009;95:614-20.
24. Stannard JP, Sheils TM, Lopez-Ben RR, McGwin G, Robinson JT, Volgas DA. Vascular injuries in knee dislocation: the role of physical examination in determining the need for arteriography. *J Bone Joint Surg Am.* 2004;86:910-5.