Risk factors for common peroneal nerve injury in knee dislocation: a retrospective study

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Research article

Keywords: knee dislocation, common peroneal nerve, posterolateral knee ligaments, risk factor

Posted Date: March 4th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-15922/v1

Abstract

Background Knee dislocation is a serious injury, representing less than 0.2% of all orthopedic injuries, and 16% to 40% of these patients suffer an associated injury to the common peroneal nerve (CPN). However, it is still unclear which structures are most intently associated with CPN injury. This study attempts to analyze the potential risk factors for CPN injury and provide clues for a comprehensive diagnosis of knee dislocation.

Methods We retrospectively reviewed 153 cases of knee dislocation related to lateral and/or posterior ligament injury between 2015 and 2018. All 153 patients were divided into the CPN injury group or the no-CPN injury group. The baseline characteristics included age, gender, cause of injury, posterior cruciate ligament (PCL) disruption, anterior cruciate ligament (ACL) disruption, popliteofibular ligament and/or tendon of popliteus injury, biceps femoris tendon injury and fibular head fracture. We identified potential variables for a multivariable logistic regression model to identify the major risk factors for CPN injury.

Results Multivariate regression analysis revealed the biceps femoris tendon injury and fibular head fracture to be predictive of CPN injury in knee dislocation. Gender, age, cause of injury, ligamentous classification, popliteofibular ligament and/or tendon of popliteus injury, PCL disruption or ACL disruption do not predict CPN injury.

Conclusions Biceps femoris tendon injury and fibular head fracture are risk factors of CPN injury in knee dislocation. A better understanding of the risk factors for CPN injury allows surgeons to achieve more accurate diagnoses.

Background

Knee dislocation is a serious injury, representing less than 0.2% of all orthopedic injuries[1], and 16–40% of these patients suffer an associated injury to the common peroneal nerve (CPN)[2]. Although knee dislocations are relatively rare, serious complications make treatment difficult. Because of the local anatomy and mechanisms of injury, knee dislocation may lead to an associated disruption of both cruciate ligaments and the posterolateral structures of the knee. Which structures of the knee protect the CPN from injury and indicate a CPN injury have not been reported. Most dislocations of the knee can reduce by themselves before becoming an emergency. This reduction may conceal many structural injuries, causing inappropriate or delayed treatment. CPN injuries indicate that there are degrees of knee dislocation and potential structural damage. However, it is still unclear which structures are most intently associated with CPN injury. The purpose of this study is to establish the relationship between CPN injury and structural damage of the knee. A series of knee dislocations from 2015 to 2018 at our institute were reviewed to analyze the potential risk factors for CPN injury and provide clues for a comprehensive diagnosis of knee dislocation.

Methods

Our institutional review board approved this retrospective study, and a waiver of informed consent was obtained. We retrospectively reviewed 532 cases of ligamentous injury of the knee joint, in which 154 knees of 153 cases presented with a diagnosis of knee dislocation in patients aged 16 to 62 years old between 2015 and 2018. One case was excluded in which the patient underwent amputation because of popliteal artery rupture; therefore, the CPN injury could not be identified. CPN injury was defined as a lack of sensation over the dorsum of the foot and 0/5 motor function as graded by the Medical Research Council criteria[3]. All 153 patients were divided into the CPN injury group or the no-CPN injury group. The causes of injury were classified into low energy and high energy. Patterns of ligamentous injury were classified according to the system for knee dislocations developed by Schenck[4]. Plain radiographs, MRI studies and operation records were reviewed to confirm associated fractures and ligamentous patterns of injury. The baseline characteristics, including age, gender, cause of injury, posterior cruciate ligament (PCL) disruption, anterior cruciate ligament (ACL) disruption, popliteofibular ligament and/or tendon of popliteus injury, biceps femoris tendon injury and fibular head fracture, are shown in Table 1.

Table 1
Characteristics of Patients

	CPN injury group (n = 11)	no-CPN injury group (n = 142)	P value
Age (years)	33.3 ± 10.6	33.4 ± 11.6	0.711
Gender			1.000
Male	8	102	
Female	3	40	
Cause of injury			0.102
Low energy	2	69	
High energy	9	73	
Classification (Schenck)			0.006
KD I	0	39	
KD II	4	70	
KD III	7	28	
KD IV	0	5	
ACL rupture PCL rupture Popliteofibular ligament and/or tendon of popliteus injury Biceps femoris tendon injury	9 6 9 2	86 75 32 4	0.281 1.000 < 0.001 < 0.001
Fibular head fracture	4	2	< 0.001

The data were processed using Statistical Product and Service Solutions 16.0 software (SPSS, Chicago, IL, USA). The differences were considered statistically significant when P values were 0.05 or less. Differences in the continuous variables (e.g., age) between the two groups were compared using Student's t-test. The categorical variables (i.e., gender, cause of injury, PCL disruption, ACL disruption, popliteofibular ligament and/or tendon of popliteus injury, biceps femoris tendon injury and fibular head fracture) were compared using a chi-squared test or Fisher's exact test. We identified potential variables for a multivariable logistic regression model to identify major risk factors for CPN injury.

Results

In our series, 11 (7.2%) of 153 patients presented with CPN (Table 2).

Table 2
Characteristics of Patients with CPN injury

No.	Gender	Age	Classification (Schenck)	ACL rupture	PCL rupture	Popliteofibular ligament and/or tendon of popliteus injury	Biceps femoris tendon injury	Fibular head fracture
1	M	24	II	Y	Y	Y	N	N
2	M	24	III	N	N	Y	N	Y
3	M	35	III	Y	N	N	N	Y
4	F	19	III	Y	Y	Y	Y	N
5	M	43	III	Y	N	Y	N	N
6	M	29	III	Y	Y	N	N	N
7	M	41	II	N	N	Y	N	N
8	F	37	II	Y	N	Y	N	N
9	M	45	III	Y	Y	Y	Y	N
10	F	49	III	Y	N	Y	N	Y
11	M	20	II	Y	Y	Y	N	Y

The univariable analysis comparing patients with and without CPN injury shows that the CPN injury group has a higher rate of popliteofibular ligament and/or tendon of popliteus injury, biceps femoris tendon injury and fibular head fracture. In addition, we find no differences in age, gender, cause of injury, ACL or PCL disruption (Table 1).

The multivariate regression analysis reveals biceps femoris tendon injury and fibular head fracture to be predictive of CPN injury in knee dislocation. Gender, age, cause of injury, ligamentous classification, popliteofibular ligament and/or tendon of popliteus injury, PCL disruption or ACL disruption are not predictive of CPN injury in knee dislocation (Table 3). Figure 1 shows a typical case.

Table 3
Multivariate analysis

Variable	P Value	Odds ration	95% confidence interval
Age (years)	0.422	0.991	0.933, 1.113
Gender	0.077	0.956	0.241, 3.787
Cause of injury Classification	0.437 0.176	4.253 3.145	0.887, 20.386 0.647, 15.762
ACL rupture PCL rupture Popliteofibular ligament and/or tendon of popliteus injury Biceps femoris tendon injury	0.648 0.134 0.224 < 0.001	2.936 1.072 15.469 40.000	0.610, 14.066 0.313, 3.674 3.180, 75.246 6.231, 256.792
Fibular head fracture	< 0.001	40.000	6.231, 256.792

Discussions

Knee dislocation generally means malalignment between the distal femur and proximal tibia usually accompanied by injuries of multiple ligaments and structures. Late presentation with multiple knee ligament injuries is not uncommon, as spontaneous relocation of the dislocated knee may lead to initial underestimation of the severity of the ligamentous and tendon disruption. This situation is particularly likely when the knee dislocation was part of multiple traumas and initial treatment priorities were focused on the compound injury rather than on the function of the knee. The difficulty of diagnosis will be further increased by joint swelling, activity limitation, and image confusion because of hemorrhage and edema. Multiple ligament knee injuries require careful evaluation to make an accurate diagnosis and to identify associated neurovascular injuries that can threaten limb viability. Knee dislocations sustained during sports generally have a lower incidence of associated neurovascular injuries when compared with those sustained in car crashes[5]. Even after successful ligament reconstruction, unresolved CPN palsy is a major factor contributing to poor outcomes after knee dislocations.

CPN injury is an important complicating factor in the setting of knee dislocation, having deleterious effects on function, neuropathic pain, and the overall quality of life[6]. Patients who suffer from a persistent foot drop have significantly worse functional outcomes[7,8]. CPN injury can be diagnosed clinically, although a high index of suspicion is needed. In our study, CPN injury is associated with dislocation of the knee in 7.2% of our series of 153 patients. This result is comparable to a study which includes 6454 patients with knee dislocation. The author reported a neurological injury incidence of 6.2% [9]. This incidence is slightly lower compared with previous studies (Table 4)[10,11,12,13]. It is more likely to

find a nerve injury in patients who present with a posterolateral corner injury[14], especially in those with biceps femoris tendon injury or fibular neck fracture probably because of their intimate contact[15,16].

Table 4
Incidence of common peroneal nerve injury with knee dislocation of the in the literature

Authors	Incidences
Harner et al	4/31 (13%)
Werier et al	6/38 (16%)
Bonnevialle et al	12/67 (18%)
Krych et al	32/160(20%)

The CPN originates as the sciatic nerve divided into the CPN and the tibial nerve at the mid- to distal-third of the thigh[17]. It curves around the proximal peroneus longus muscle to travel toward the anterior lower leg, where it divides into the deep and superficial branches. Several anatomical factors predispose the CPN to injury. The CPN passes laterally to the fibular neck, which forms the floor of the so-called fibular tunnel[18]. The tunnel entrance is a musculo-aponeurotic arch derived from the soleus and peroneus longus muscles, at which point, the CPN is superficial and relatively constrained proximally at the fibular neck and distally at the intermuscular septum by fibrous arches that limit its ability to accommodate changes in limb position during trauma[14]. Therefore, the nerve is highly vulnerable to stretch injury during varus stress, particularly in posterolateral corner injuries. Peroneal nerve injury from excessive traction is often characterized by axonotmesis over a long nerve segment. Neurotmesis can occur but usually presents as a long, stretched, and contused nerve segment. Electroconduction studies may be helpful to assess the severity of nerve injury[19]. Orthopedic surgeons treating patients with knee dislocations must keep in mind the surrounding factors before managing ligamentous reconstructions[20]. Lustig reported that 17% of patients with knee dislocation had ipsilateral limb fracture[21]. Becker reported a greater incidence of fractures in the ipsilateral limb at 58%[22].

Injury of some important structures, such as the biceps femoris tendon and/or fibular head, may prompt CPN palsy. In our study, we find that patients with biceps femoris tendon and/or fibular head injury have a much higher rate of CPN injury. So this so-called “protection chain” play an important role in knee dislocation patients. CPN repair or decompression should be performed during lateral ligament reconstruction in patients with associated CPN injury. Doctors should also be highly alert of a biceps femoris tendon and/or fibular head injury in CPN palsy cases.

There are also several weaknesses of our study. The relatively small sample size of the current study may be associated with some bias. A multiple-center study could be more beneficial. In addition, we did not

stratify partial versus complete or ruptured versus contused injuries in this study. Lastly, this research is a cross-sectional study, and the prognosis of CPN injury is not the purpose of this research.

List Of Abbreviations

CPN: common peroneal nerve; PCL: posterior cruciate ligament; ACL: anterior cruciate ligament

Declarations

Ethics approval and consent to participate: The study was approved by the Ethic Committee of Peking University International Hospital. All patients involved had given informed consent.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: This study was supported by grants from Peking University International Hospital Research Funds (grant number YN2016QN10).

Authors' contributions: TL collected, analyzed, and interpreted the data and wrote the draft. ZK revised the draft. WJF, LXG, XX, WXH, YB, XZL assisted in collection of data. LC performed the surgery, designed the protocol, and collected data of this study. All the authors have read and approved the final manuscript.

Acknowledgements: Not applicable.

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Figures

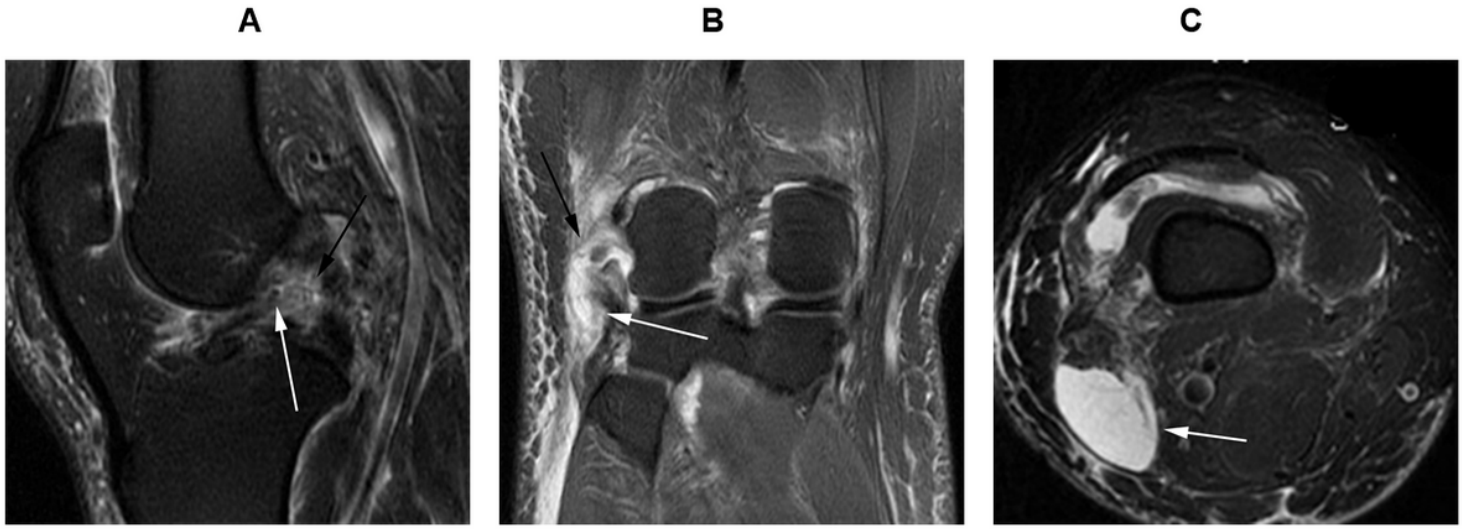

Figure 1

A 41 years old man, got a knee dislocation in wrestling competition. MRI showed a clear ACL (white arrow) and PCL (black arrow) rupture (A), lateral collateral ligament (white arrow) and femoral biceps tendon (black arrow) rupture (B), trace of CPN injury (C).