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Operative Techniques in

Sports Medicine

Management of Arterial and Venous Injuries in the Dislocated Knee

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Vascular injury associated with knee dislocation (KD) resulting from multiligament knee injury is a treacherous condition. The orthopaedic injury itself is uncommon and it is accompanied by a vascular injury in only a few cases. In a series of KDs reported since 1992, injury to the popliteal artery has been reported to occur in 7%-32% of cases. In 2014, reviews of 2 large databases of KD by authors from the same institution reported vascular injury frequency of 1.6%-3.3%. The outcome of missed arterial injury causing ischemia is predictably disastrous, so the index of suspicion for this uncommon entity must be high. Significant arterial injury demands prompt recognition and efficient management to prevent devastating consequences. The mechanisms of popliteal vascular injury in KD are reviewed. Diagnostic modalities used to evaluate vascular injury are discussed. Efficient detection and treatment of significant vascular injury is crucial, and an algorithm for diagnosis and management is reviewed. The salient features of vascular reconstruction are elaborated within the context of the dislocated knee and the vascular surgical approach, conduct of the procedure, and adjunctive maneuvers are described. Thoughtful location of the vascular reconstruction would facilitate subsequent orthopaedic reconstruction and minimize the risk of injury to the vascular repair.
Oper Tech Sports Med 23:362-371

KEYWORDS popliteal, artery or arterial, dislocation, ischemia, knee, injury

Introduction

Vascular injury regularly accompanies multiligamentous dislocation of the knee. Both entities are uncommon and thus prone to be underappreciated by those who evaluate the patient at the time of injury. In a 2006 survey of Academic Primary Care Physicians, only 55% understood the need to assess the vascular status of the affected limb after knee dislocation (KD), and only 39% knew that it was the popliteal artery that was at risk.[1] Clearly, there is a lack of understanding of the implications of this injury even within the physician ranks. If the injury is significant and results in ischemia, a high clinical index of suspicion, rapid diagnosis, evaluation, and correction are necessary to avoid an undesirable outcome. Those who have experienced the severe complications resulting from a missed vascular injury are unlikely to forget its indelible imprint. Those who have no experience with this condition are in the majority and likely to blithely underappreciate its malice.

KD itself is an infrequent injury. It accounts for less than 1% of all extremity injuries. Its rarity adds to the danger of underappreciation of the potential for associated vascular compromise. Modern diagnostic imaging, particularly magnetic resonance imaging (MRI), has increased the ability to diagnose the orthopaedic condition, which previously relied on clinical evaluation, which is often unreliable. In all, 2 important practical considerations are relevant. Firstly, there is a high incidence of spontaneous reduction of the dislocation by the time orthopaedic evaluation is performed, which reduces the likelihood of recognizing the injury as a dislocation. Secondly, the knee MRI is generally not obtained at the time of initial injury and is therefore not a factor in the initial vascular diagnostic algorithm.

Vascular injury is associated with KD in a few of the KD cases. Popliteal artery injury rates range from 7%-100% in multiple series of KDs.[2–19] The frequency of associated vascular injury in reports published since 1992 ranges from 7%-32%[10–19] (Table). A frequently quoted average is 30%. In 2014, a group from University of California, Los Angeles,

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 http://dx.doi.org/10.1053/j.otsm.2015.08.001
1060-1872//

Table Results of 18 Studies of Knee Dislocation and the Association With Popliteal Artery Injury and Amputation

References	Knee Dislocations	PA Injuries	Amputations
1. Hoover[2]	14	7 (50%)	11 (92%)
2. Kennedy[3]	22	7 (32%)	5 (23%)
3. Green et al, 1977	245	78 (32%)	31 (13%)
4. O Donnell et al[5]	10	10 (100%)	2 (20%)
5. Jones et al[6]	22	10 (45%)	1 (5%)
6. Sisto and Warren[7]	20	2 (10%)	0 (0%)
7. Roman et al[8]	30	10 (33%)	0 (0%)
8. Varnell et al[9]	30	12 (40%)	2 (7%)
9. Treiman et al[10]	115	23 (20%)	1 (0.9%)
10. Kaufman and Martin[11]	19	6 (32%)	0 (0%)
11. Dennis et al[12]	38	9 (24%)	0 (0%)
12. Kendall et al[13]	37	6 (16%)	1 (3%)
13. Wascher et al[14]	47	11 (23%)	1 (2%)
14. Martinez et al[15]	21	7 (33%)	0 (0%)
15. Abou-Sayed and Berger[16]	53	13 (25%)	1 (2%)
16. Miranda et al[17]	35	7 (20%)	0 (0%)
17. Mills et al[18]	38	11 (29%)	1 (3%)
18. Stannard et al[19]	138	9 (7%)	0 (0%)
19. Medema et al, 2014	862	171 (18%)	22 (12%)
20. Natsuhara et al[20]	8050	267 (3.3%)	NR
21. Werner et al[21]	215	10 (4.7%)	1 (0.5%)
22. Georgiadis et al[22]	53	7 (13%)	1 (2%)
23. Sillanpaa, 2014	837	13 (1.6)	1 (0.1%)
Total	**10,951**	**706 (6.4%)**	**82 (0.8%)**

PA, popliteal artery.

published 2 large database reviews with much lower frequencies of KD-associated vascular injury with rates of 3.3%–18%. A 2013 nationwide database study from Finland reported an incidence of only 1.6% of patients with KD requiring emergent vascular reconstruction. Among these frequency rates, 2 rates are much lower than those reported historically. There remains a lack of clarity as to the frequency of KD-associated vascular injury and the rate at which immediate vascular reconstruction would be required. What remains clear is the unfavorable outcome if significant injury is missed.

Some of the variability in frequency rates can be explained by a lack of uniform definition and reporting of vascular injury in different studies. Some reports include venous injury, which is less devastating than arterial injury but bad in combination. Many injuries are minor and heal spontaneously without consequence. Some report only significant vascular injuries, which likely present with ischemia or less frequently, hemorrhage and require immediate treatment for a successful outcome. When missed on the initial assessment, it is this subgroup with significant arterial vascular injury that accounts for a disproportionate percentage of the serious morbidity, limb loss, and medicolegal exposure.

Recognition of the association of vascular injury with KD is a prerequisite to successful application of the management strategy. It is helpful to review the mechanics of vascular injury, vascular evaluation, vascular repair, and adjunctive measures, as they apply to KD. Although the vein may also be injured, the primary focus is on arterial injury as that is the most likely determinant of ultimate vascular outcome.

Mechanics of KDs and the Causation of Vascular Injury

Multiligamentous disruption of the knee results in injury to the soft tissues in the region. Depending on the magnitude and mechanics of the disruption, neurovascular injury may occur. The mechanism of neurovascular injury is predominantly excessive stretching with some component of mechanical contusion also possible. Owing to an intrinsically poor collateral pathway bridging the popliteal region, severe ischemia is most often the result of acute popliteal artery occlusion. Without immediate recognition and rapid correction of perfusion, muscle and tissue necrosis occurs within hours and above-knee amputation is the most likely outcome. A delay in correction of ischemia in excess of 8 hours nearly always results in amputation. Better salvage results are seen with more rapid revascularization.

In the modern era, most of the KDs result from high-energy trauma predominantly involving motor vehicles. Trauma to the legs may result from dashboard contact for vehicle occupants, vehicle contact for pedestrians, and environmental contact for motorcycle riders. These mechanisms most commonly result in posterior dislocations. The next largest group of KDs results from medium-energy trauma, most commonly sporting events such as football, gymnastics, and trampoline activities. Some result from low-energy trauma, which includes falls and missteps, particularly in the obese people. Even these low-energy-induced KDs are associated with a 4.7%-28.1% incidence of vascular injury.[20–22] Traditionally, the risk of