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Knee dislocations – a retrospective study comparing operative versus closed immobilization treatment outcomes

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Abstract Controversies over operative versus closed immobilization of traumatic complex multiple ligamentous knee injury are still debated. The aim of our study is to evaluate the outcome of reconstructive vs non-reconstructive (closed immobilization) treatment outcomes. This is a retrospective review of cases seen at our institution. All cases admitted with a diagnosis of knee dislocation, defined as patients with multidirectional knee instability in the setting of trauma, were reviewed. Twenty-nine consecutive patients from January of 1996 to June of 2002 were reviewed. Twenty-six patients (89.7%) were successfully recalled and their functional outcome analyzed. Comparing the operated group (n=15, 57.7%) with closed immobilized patients (n=11, 42.3%), there was no statistical difference in the range of motion (mean difference 8.55°, p=0.202). While the operated group had more flexion contracture (mean difference 3.9°, p=0.002), they had better stability and better overall knee function as measured by the International Knee Documentation Committee (IKDC) score (the mean difference of IKDC score was 12.13, p=0.005). In the operated group of 15 patients, we compared partial repair (n=7) with complete repair of all torn ligaments (n=8). Superior results were noted in the group with complete repair of all structures, with comparable range of motion (mean difference 0.6°, p=0.861) and flexion contractures (mean difference 1.0°, p=0.795) but better stability and IKDC score (mean difference of IKDC score 13.6, p=0.003). Our conclusion is that operative treatment with complete repair of all torn structures produces the best overall knee function with better knee stability and patient satisfaction.

Keywords International Knee Documentation Committee (IKDC) score · Complex ligamentous knee injury · Knee function · Surgery · Functional outcome

Introduction

Traumatic knee dislocation leading to complex, multiple ligamentous injury of the knee is a rare injury. Many of these injuries reduce spontaneously, and hence the true incidence of knee dislocation is unknown [1, 2, 3]. However, with a reported incidence of knee dislocation ranging from 0.001% to 0.013%, an orthopedic surgeon is likely to encounter only a handful of cases in his career [1]. A dislocation should be suspected in a knee with gross instability of two or more ligaments following trauma, despite the reduced joint on radiographs [4]. Subsequent evaluation and treatment should be performed under the assumption that a dislocation has occurred [1, 2, 4, 5]. This condition is a surgical emergency with potential for neurovascular compromise and limb loss. This mandates early recognition and appropriate initial assessment. Be-

cause of the rarity and heterogeneity of these injuries, the ideal management of knee dislocation remains controversial. The focus of this study is to review the functional outcome of this condition treated operatively and by closed immobilization (non-reconstructive treatment) at our institution.

Materials and methods

A retrospective study was carried out on consecutive cases of knee dislocations, looking specifically at presentation, diagnosis and outcome. All patients with a discharge diagnosis of knee dislocation in our hospital computer database from January 1996 to June 2002 were reviewed. Additional cases were identified from operating theatre log-books during this period. Inclusion criteria included the following: a documented knee dislocation at presentation, or finding of multiple ligamentous knee injury on clinical and radiological (magnetic resonance imaging [MRI] scan of the knee) examination in the setting of trauma. Patients with complex fracture-dislocations, such as associated tibia-plateau fracture [6], were excluded from this study as the associated joint-line disruption and bony malalignment may confound the outcome of treatment.

The measured variables in this study were the following: (a) age, (b) sex, (c) mechanism of injury, (d) types of knee dislocations, (e) presence of neurovascular compromise and (f) operative findings and procedures. Frank dislocation was defined as dislocation noted by the admitting physician and reduced at the emergency department. It is well established that in the setting of trauma, a knee with multidirectional instability should be treated as a dislocated knee with equal potential for neurovascular compromise [1, 2, 4, 5]. We therefore defined spontaneously-reduced dislocation as knee injury with no documented dislocation on admission, but found to have multidirectional knee instability, with at least a torn anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), on clinical and radiological (MRI scan) examination [1, 2, 4, 5].

Mechanism of injury was divided into high velocity (road-traffic accidents, fall from heights) and low velocity (jumping off low heights or twisting injuries) groups. Classification based upon the relative displacement of the tibia with respect to the femur was used. Direction of instability was defined as anterior, posterior, medial, lateral or posterolateral (rotatory) [1, 7, 8]. Patients were recalled, and the affected knee function was evaluated subjectively and objectively using the IKDC 2000 knee-ligament standard evaluation form. All patients were evaluated clinically by a single investigator.

Statistical analyses were performed using the SPSS statistical software (version 11.0). Univariate analysis was performed by chi-square tests or by Fisher's exact probability test for comparison of proportion between the two groups. A p-value of less than 0.05 was taken as statistically significant. For continuous variables, non-parametric assumptions were made because of the skewed distribution of our small data set. For comparison of the mean between the two groups, the Wilcoxon test was used.

Results

Twenty nine consecutive patients from January of 1996 to June of 2002 were identified. Twenty six patients (89.7%) (24 male and 2 female) were successfully recalled, and our analysis of outcomes was based on these 26 patients. The median age at presentation was 22 years, with a range of 11 to 54 years of age. The mechanism of injury was high velocity in 13 patients (50%) and low velocity in 13 patients (50%). The left knee was affected in 8 patients (30.8%) and the right knee in 18 patients (69.2%). Fifteen patients (57.7%) had sustained a knee dislocation at presentation, and all were successfully reduced without operation. Eleven patients (42.3%) sustained a spontaneously reduced knee dislocation. There were associated ligamentous and tendinous avulsion fractures in nine patients (34.6%). Three patients sustained frank dislocation with one of the cruciates intact (one patient with an intact ACL and two with an intact PCL). The mechanisms of injury were low-velocity in all three of these patients. On evaluation, seven patients had anterior instability, ten had posterior instability, two had medial instability, four had lateral instability and three had rotatory instability. An angiogram was done selectively in patients with suspected vascular injuries (e.g. pulse deficit, poor capillary refill of the extremity) [5]. We did angiograms for seven patients. One patient sustained vascular injury. One patient had transient peroneal nerve palsy. The peroneal nerve was not explored, and his foot-drop subsequently recovered with only mild weakness. The median duration of follow-up was 33.5 months, with a range of 6 to 144 months.

Eleven patients (42.3%) were treated by closed immobilization (casting or with external fixation) while 15 patients (57.7%) were treated operatively. Surgical treatment was evolving throughout the time period under study. Earlier in our study period, surgical treatment of multiple ligamentous knee injury ranged from suture repair of all disrupted ligaments to uni-cruciate reconstruction (usually only the ACL). We classify this group as the partially-repaired group (n=7, 26.9%). More recently, patients were treated with complete reconstruction of all torn structures with various autografts (n=8, 30.8%).

In this study, the following five measures of outcomes were assessed: range of motion (ROM), objective instability, subjective rating, return to athletic activities and the IKDC score. The IKDC score is a tool which is commonly used for subjective and objective assessment of knee function. The scale encompasses measures such as pain, swelling, instability, functional assessment (one-leg hop) and physical examination. The knee is graded based on these factors, with a normal knee achieving a score of 100. An IKDC score of 90 and above was considered excellent, 90–70 was good and a score of less than 70 was considered suboptimal.

The mean ROM for the operated group was 128.8° (range 105°–165°) and for the non-operated group was 136.8° (range 105°–160°). This mean ROM difference of 8.55° in the ROM was not statistically significant (p= 0.202). The operated group however had more flexion contracture, with a mean of 5.7° compared to 1.8° in the non-operated group (mean difference 3.9°, p=0.002). Mean anterior–posterior tibial translation for the operated group was 4.6 mm (range 2–12 mm) and for the non-operated group, the mean was 9.4 mm (range 5–12 mm) (mean dif-

Table 1 Univariate analysis of measures of outcome of the operated group versus the non-operated (conservative) group. *Op* operated group, *No-op* non-operated group, *AP translation* anterior–posterior tibial translation, * Wilcoxon test

Variable	Mean	Standard deviation (SD)	*P* value
ROM			0.202*
Op	128.27°	18.069	
No-op	136.82°	18.066	
Flexion contractures			0.002*
Op	5.7°	2.94	
No-op	1.8°	2.27	
AP translation			0.001*
Op	4.6 mm	2.995	
No-op	9.4 mm	2.942	
IKDC score			0.005*
Op	75.84	10.01	
No-op	63.71	9.07	

Table 2 Univariate analysis of measures of outcome of the partial-repair group compared with the complete-repair group. *P* partial-repair group, *C* complete-repair group, *AP translation* anterior–posterior tibial translation, * Wilcoxon test

Variable	Mean	Standard deviation (SD)	*P* value
ROM			0.861*
P	128.6°	18.2	
C	128.0°	19.2	
Flexion contractures			0.759*
P	5.1°	3.9	
C	6.1°	1.9	
AP translation			0.004*
P	6.71 mm	2.99	
C	2.75 mm	1.39	
IKDC score			0.003*
P	68.6	7.49	
C	82.2	4.30	

ference 4.8 mm, p=0.001). Subjectively, knee instability among the operated group was reported in 26.7% (n=4) of patients and knee instability for the closed immobilized group was 90.9% (n=10) (p=0.002). The mean IKDC score for the operated group was 75.8 (SD±10.0, range 56.9–86.2), and for the non-operated group the mean was 63.7 (SD±9.07, range 48.4–80) (mean difference 12.1, p=0.005) (Table 1).

A comparison between the partial-repair and complete-repair group was performed. Subjective instability was reported by four patients in the partial-repair group, whilst none of the patients in the complete-repair group reported and subjective instability (p=0.026). Objective comparison made between the partial-repair and complete-repair groups showed no difference in the mean ROM between the two groups (mean difference 0.6°, p=0.861). The mean AP translation (mean difference 4.0 mm, p=0.004) and mean IKDC score (mean difference 13.6, p=0.003) were however significantly better for the complete-repair group (Table 2).

There was no statistically-significant difference in the IKDC scores between patients with frank dislocations and occult dislocations. Similarly, there were no statistical differences in the mean IKDC scores for different mechanism of injury (high vs low velocity injuries) or presence of avulsion fractures, nor between patients operated on early (within 2 weeks) or late (after 2 weeks) (Table 3).

An IKDC score of more the 70.0 was considered good, whilst a score of less than 70.0 was considered suboptimal. Using this criterion, 12 patients (46.2%) achieved good results, whilst in 14 patients (53.8%) the results were only fair. Twenty-one patients (80.8%) reported that the injury has affected their quality of life. None were able to return to their level of sporting activities prior to their injuries. Complications in our series were infrequent. One patient (3.8%) had arterial (popliteal artery) occlusion and one patient (3.8%) had peroneal nerve palsy. There was no limb loss in our series. Part of the reason for this may be that once a vascular compromise is detected the patients are often transferred to another hospital with a dedicated vascular unit, and therefore not reflected in this review.

Table 3 Univariate analysis of outcome using the IKDC scores. * Wilcoxon test

Variable	*P* value
Frank dislocation vs occult dislocation	0.499*
Avulsion fractures vs no avulsion fractures	0.177*
Early repair vs late repair	0.295*
Mechanism of injury: low velocity vs high velocity	0.281*

Discussion

Knee dislocation is a grave injury not commonly encountered. Due to its rarity, there are few studies addressing the treatment modalities of this injury. Taylor et al. [9], Mitchell[10] and Thomsen et al. [11] published studies favoring non-surgical approach while more recent studies have favored operative treatment [1, 12, 13, 14]. It is difficult to reconcile the difference in opinion between those who advocate closed reduction without ligamentous repair and those who recommend early operative repair of all damaged structures.

Range of motion (ROM) has been a major concern for surgeons treating knee dislocations for more than 2 centuries. In 1743, Heister [15] wrote about knee dislocations, stating “it is difficult to make a perfect cure thereof without letting the bone join together, or leaving some stiff-

ness in the knee". Perhaps it was this observation that promoted the assumption that stability can only be obtained at the expense of motion, and led initially to the largely non-operative approach with closed immobilization of the affected knee.

During the $5^1/_2$ year study period we treated 29 patients, with 26 patients (89.7%) successfully recalled for evaluation. Eleven patients (42.3%) were treated with closed immobilization (casting or external fixation) while 15 patients (57.7%) were treated operatively. The mean ROM for our operated patients was 128°, compared with a mean of 137° in the conservatively treated patients. This difference was however not statistically significant. When considering flexion contractures, however, we found that this was significantly more in the operated group (5.7 mm vs 1.8 mm). ROM and flexion contractures are measures of stiffness of the knee joint. Whilst not convincingly demonstrated, due to the small sample size, there seemed to be more stiffness in the operatively-treated knee dislocation.

With regard to stability, however, patients treated operatively clearly fared better both subjectively and objectively. They felt more secure subjectively, and their anterior–posterior translation is significantly less. Overall, the IKDC scores of operatively-treated patients were significantly better than conservatively-treated patients. Whilst we noted the competing interests of chronic instability vs ankylosis in our study, the benefits of stability was achieved at the expense of marginally more stiffness in the operated knee. This resultant stiffness in the operated knee did not however translate into gait disturbance. Patients did however have difficulty squatting. Overall, however, the operated knee appeared to function better, as reflected by the better IKDC scores achieved and by patient satisfaction.

Earlier on in our experience, the operative technique we employed ranged from suture repair of disrupted ligaments to delayed reconstruction of selective ligaments or uni-cruciate reconstruction (usually the ACL). More recently, we shifted our strategy to simultaneous repair of anterior and posterior cruciate ligaments, with repair of all other torn structures. The operative outcomes of the former (partial-repair group) were compared with the latter (the complete-repair group).

Yeh et al. [16] performed a study on uni-cruciate reconstruction in 25 patients with knee dislocations. They noted slightly better ROM but increased instability when compared to other surgically treated patients. Studies on bi-cruciate reconstructions reported varying results [17, 18]. In our analysis, when considering stiffness, there was no statistical difference in the ROM and flexion contractures between the partial-repair group and the complete-repair group. The complete-repair group, however, has better subjective and objective (anterior-posterior translation) stability and an overall IKDC score. Operations on the knee would result in stiffness from soft-tissue scarring and post-operative immobilization, regardless of the extent of the repair. Stability, however, would be much better if all torn structures were meticulously repaired or reconstructed. In our experience, therefore, once a surgical course of treatment has been committed to, a complete repair and/or reconstruction of all torn structures offers the best chance of an optimal outcome.

When considering the outcomes of operative vs conservative treatment, the role of early intensive and aggressive physiotherapy could not be over-emphasized [17]. The favorable outcome of our patients treated operatively (good stability, with only marginally more stiffness) may in part be attributed to the early, aggressive protected range of motion and strengthening exercises. We usually immobilize our patients for about 3 weeks before commencing protected range of motion exercises. In contrast, patients on conservative treatment (cast or external fixator) are committed to 6 to 8 weeks of immobilization to allow for healing and scarring [9].

Fifteen patients (57.7%) had sustained a knee dislocation documented at presentation, whilst 11 patients (42.3%) sustained spontaneously-reduced knee dislocation. We found no statistical difference in the outcome (as measured by the IKDC score) between these two groups of patients. Spontaneous reduction and reduction by paramedical staff may mask the severity of the injury. Therefore, in the setting of trauma, a patient with multi-ligamentous instability should be regarded as having sustained a knee dislocation and treated as such [1, 2, 4, 5]. Particular attention should be paid to the neurovascular status of the affected limb, as it has also been reported that the incidence of neurovascular injury is the same in a frankly-dislocated knee and a spontaneously-reduced knee dislocation [16].

It is generally recommended that surgical repair should be done within 14 days of the initial injury, after the acute inflammation has settled, before the scarring process sets in with increased risk of complications [1]. Whilst we try to operate on our patients early, often the associated injuries (fractures, open wounds or neurovascular injuries) may not permit this. We were also concerned that the presence of a torn posterior knee capsule may cause extravasation of irrigation fluid used in arthroscopic knee ligamentous reconstruction. When a delay is deemed necessary, we will start the patient on protected ROM exercises as tolerated, and operate on them when the ROM achieved is at least 90°. We found no statistical difference in the IKDC score between patients operated on early (within 14 days) or late.

It was widely held that both cruciates must be disrupted to allow sufficient tibia displacement for a knee dislocation to occur [1]. Recent clinical observations and laboratory investigations have demonstrated that knee dislocation with single cruciate ligament intact is possible, particularly in the setting of low-velocity dislocations [19, 20]. Three of our patients with knee dislocations had an intact PCL or ACL. A high index of suspicion should be maintained when assessing trauma patients with multiple ligamentous injury, even though one of the cruciates maybe

intact. A dislocated knee with an intact cruciate is equally at risk of neurological compromise, and should be carefully assessed and monitored [19, 20].

Whilst there has been significant advancement in the treatment of knee dislocation, there is still much to aspire to. In our 26 patients, 21 patients (80.8%) reported at follow-up that their quality of life has been adversely affected by the knee injury. None of our patients were able to return to their previous level of athletic involvement. It is therefore important to inform the patient early in the course of treatment of the severity of this injury, and that it is unlikely that the knee will function normally, regardless of treatment.

Conclusion

There are inherent weaknesses in our study that must be acknowledged: the small sample size and the diverse nature of the injuries when they occur. Knee dislocation can potentially cause a diverse permutation of ligamentous, soft-tissue and bony injuries. It is neither illuminating nor reasonable to lump these diffuse injuries into a single category. In the writings of Sir Astley Cooper concerning knee dislocations in the early 19th century, he commented 'There are scarcely any accidents to which the body is liable which more imperiously demand immediate amputation than these'. Treatment philosophy has certainly evolved since that time, and will continue to shift as new data emerges. Whilst it is difficult to conclude with absolute certainty from our study, we believe that operative repair of all torn ligaments resulted in a more stable knee and produced more reliable results. Early, aggressive protected range of motion and strengthening exercises are crucial and can significantly reduce post-operative stiffness.

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