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Increased Body Mass Index is Associated with Worse Mid- To Long-Term Patient Outcomes after Surgical Repair of Multiligamentous Knee Injuries

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Abstract

We evaluated the relationship between elevated body mass index (BMI) and mid- to long-term outcomes after surgical treatment of multiligamentous knee injury (MLKI). Records identified patients treated surgically for MLKI at a single institution. Inclusion criteria: minimum 2 years since surgery, complete demographics, surgical data, sustained injuries to two or more ligaments in one or both knees, and available for follow-up. Patients were contacted to complete patient-reported outcomes assessments and were classified according to mechanism of injury. Multivariate logistic regression analysis was used to predict the impact of BMI on outcome scores. A total of 77 patients (72.7% male) were included with a mean age at the time of injury of 29.4 ± 11.0 years and a mean BMI of 30.5 ± 9.4 kg/m^2. The mean length of follow-up was 7.4 years. For each 10 kg/m^2 increase in BMI, there is a 0.9-point decrease in Tegner activity scale ($p = 0.001$), a 5-point decrease in Knee Injury and Osteoarthritis Outcome Score (KOOS)-pain ($p = 0.007$), a 5-point decrease in KOOS-ADL ($p = 0.003$), a 10-point decrease in KOOS-QOL ($p = 0.002$), and an 11-point decrease in KOOS-Sport ($p = 0.002$). There were no significant correlations with BMI and Pain Catastrophizing Scale or Patient Health Questionnaire scores. Increasing BMI has a negative linear relationship with mid- to long-term clinical outcomes including pain, ability to perform activities of daily living, quality of life, and ability to perform more demanding physical activity after MLKI. BMI does not appear to have a significant relationship with knee swelling and mechanical symptoms or patients' mental health.

Keywords
- ► body mass index
- ► multiligamentous knee injury
- ► clinical outcomes
- ► anterior cruciate ligament
- ► posterior cruciate ligament
- ► medial collateral ligament
- ► lateral collateral ligament

Multiligamentous knee injury (MLKI) is defined as the presence of two or more torn ligaments in the knee, including the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament, and lateral collateral ligament (LCL). Injuries to the LCL are rarely isolated, as there are often additional injuries to the components that make up the posterolateral corner of the knee. MLKI may occur after an acute knee dislocation (KD) and can be severe, limb-

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threatening injuries that may result in long-term physical impairments. Vascular and neurological injuries may also occur creating further challenges when managing these patients.[1,2]

MLKI can have debilitating effects on patients that last for months to years with varying degrees of severity. Studies have reported recurrent instability as well as impairment in knee strength, range of motion, and function up to 2 years after treatment of MLKI.[3,4] Additionally, the percentage of patients who are able to return to work following MLKI has ranged from 58 to 81%, whereas the percentage of patients who are able to return to previous sporting activity has been lower, ranging from 22 to 63%.[4–6]

Elevated body mass index (BMI) has been associated with an increased risk of MLKI from low energy trauma, such as a ground-level fall, that can occur during normal everyday activity.[7–10] Previous work has examined the relationship between BMI and surgical complication rates and associated comorbidities resulting from MLKI.[8,11–16] Several of these studies have addressed the correlation between BMI and incidence of vascular and nerve injuries occurring in conjunction with MLKI.[9,11,13,14,17,18] These concomitant injuries are associated with significantly worse clinical outcomes.[19] Studies have also examined the effects of elevated BMI on other surgical-related complications.[11,14,20] Lian et al reported higher rates of wound infection and longer surgical times for obese patients, but lower rates of arthrofibrosis and no difference in deep vein thrombosis, revision surgery, or hardware removal compared with lower BMI patients.[11] Ridley et al found a 9.2% increase in complication rates per 1-point increase in BMI as well as an increased risk of neurovascular injury for obese patients.[14]

While other studies have addressed correlations between BMI and MLKI outcomes, most have primarily focused on surgical complications and short-term outcomes. Few have addressed patient-reported outcome measures.[8,9,11–18] There remains a paucity of data in the literature regarding the impact of BMI on mid- to long-term patient-reported outcomes after MLKI. Given the long-term disabling nature of these injuries and the increasing prevalence of obesity, it is important to understand the relationship between BMI and clinical outcomes multiple years after surgery. Also, while surgical complications and morbidity are important outcomes in orthopaedics, these do not fully encompass the patient's experience. More recently, there has been a shift in health care delivery to focus on patient's perception of their care and outcomes. In orthopaedic surgery, this is arguably a more important measure as the goal with most orthopaedic procedures are to restore function and quality of life (QOL) for patients.

The purpose of this study is to evaluate the relationship between elevated BMI and mid- to long-term outcomes after surgical treatment of MLKI. We hypothesize that there is a negative relationship between increasing BMI and patient-reported outcome scores at mid- to long-term follow-up.

Methods

After Institutional Review Board (IRB) approval, a preliminary search of the surgical billing records was conducted to identify patients treated surgically for MLKI between July 2005 and June 2018 at a single institution. The following Current Procedural Terminology (CPT) codes were used to identify patients for inclusion in the study: 27405 (repair of knee ligament), 27427 (ligamentous reconstruction, knee), 29889 (arthroscopically aided PCL repair or reconstruction). A total of 901 patients were queried using these CPT codes. Patients were included in this study with a minimum 2 years since surgery, complete demographics, and surgical data, and if available for follow-up. Patients were only included if they had sustained injuries to two or more ligaments in one or both knees. Patients with isolated ligamentous injury or patellar instability were excluded from the study (521 patients). Patients who were less than 18 years of age at the time of data collection were excluded from the study. Chart review was completed, and a total of 202 patients were confirmed to have a MLKI (►**Fig. 1**). Data collection included: patient demographic information (age, sex, height, weight, BMI), history (mechanism of injury, type of injury, activity level), associated injuries, length of follow-up in the chart, and outcomes (complications and repeat knee surgery in the chart).

Mechanism of injury was classified as ultralow velocity (ground-level fall), low velocity (sports-related), or high velocity (motor vehicle accident, fall from height). Injuries were also classified using the Schenck classification of KD.[21]

Patients were subsequently contacted to complete an assessment of functional outcomes with the Tegner activity scale and Knee Injury and Osteoarthritis Outcome Score (KOOS) and an assessment of patient's mental and overall health using the Pain Catastrophizing Scale (PCS) and Patient Health Questionnaire (PHQ-9). The authors initially attempted to contact patients by phone to complete the questionnaire. Patients who were not available by phone were sent an email with a link to complete the questionnaire online.

All statistical analyses were performed using Stata (version 14.0). Multivariate logistic regression analysis was then used to predict the impact of BMI on outcome scores while controlling for patient age at time of the injury and mechanism of injury. Subgroup analysis was conducted to compare patients who sustained a neurological injury with those who did not. A *t*-test for continuous variables and Fisher's exact test for categorical variables were used to compare the neurological injury and non-neurological injury groups. A value of $p < 0.05$ was considered statistically significant for all tests.

Results

A total of 77 patients completed patient-reported outcomes scores at a mean follow-up of 7.4 years from surgery (range: 2.4–15.7 years). Mean age at the time of injury was 29.4 ± 11.0 years and mean BMI at the time of injury was

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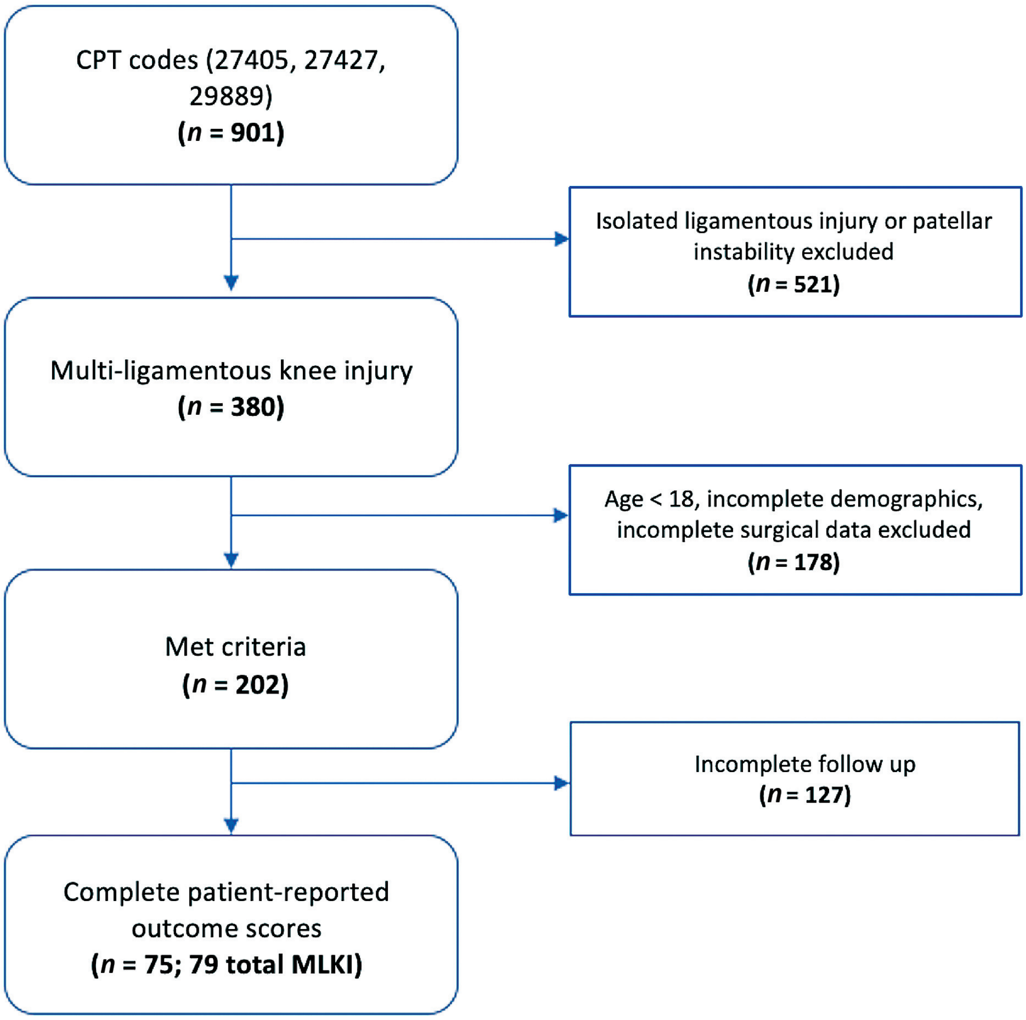

Fig. 1 Inclusion criteria based on chart review. n = number of patients. CPT, Current Procedural Terminology; MLKI, multiligamentous knee injury.

30.5 ± 9.4 kg/m^2. Out of 77 patients, 56 were male (72.7%). Overall patient reported outcome scores at follow-up were KOOS symptoms: 75.8 ± 16.4, KOOS-pain: 82.7 ± 15.6, KOOS-ADL: 88.0 ± 14.9, KOOS-Sport: 66.5 ± 30.5, and KOOS-Knee QOL: 58.6 ± 25.3, Tegner: 5.1 ± 2.2, PHQ-9: 3.0 ± 3.5, and PCS: 5.2 ± 7.6.

Low-velocity injuries were the most common mechanism of injury, with 45 patients (58.4%) in this cohort (►**Table 1**).

Table 1 Injury velocity and Schenck classification distribution

Injury velocity	Total number of injuries
Ultralow	6 (7.8%)
Low	46 (59.7%)
High	25 (32.5%)
Schenck classification	
KD I (ACL or PCL and MCL or LCL/PLC)	49 (62%)
KD III-L (ACL and PCL and LCL/PLC)	12 (15%)
KD III-M (ACL and PCL and MCL)	10 (13%)
KD IV (ACL and PCL and MCL and LCL/PLC)	7 (9%)
KD V (dislocation + fracture)	1 (1%)

Abbreviations: ACL, anterior cruciate ligament; KD, knee dislocation; LCL, lateral collateral ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament; PLC posterolateral corner.

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Table 2 Comparison of neurological injury to non-neurological injury patients

Patient characteristics	Nerve injury $N=6$	No nerve injury $N=73$	*p*-Value
Age[a], y	21.3 ± 3.2	30.5 ± 11.1	0.048
Sex, M (%)	6 (100%)	48 (65.8%)	NS
BMI[a], kg/m^2	29.7 ± 3.2	30.6 ± 9.8	NS
KD classification			0.019
I	1 (16%)	47 (64.4%)	
II	0	0	
IIIM	0	9 (12.3%)	
IIIL	3 (50%)	10 (13.7%)	
IV	2 (33)	6 (8.2%)	
V	0	1 (1.4%)	
Mechanism of injury			NS
Ultralow velocity (fall)	0	6 (8.2%)	
Low velocity (sports)	4 (66%)	42 (57.5%)	
High velocity	2 (33%)	23 (31.5%)	
Length of follow-up[a], y	3.4 ± 1.2	7.5 ± 3.9	0.013
Tegner	6.3 ± 2.8	5.0 ± 2.1	NS
KOOS-pain	88 ± 6.9	82.3 ± 16.1	NS
KOOS-symptoms	88 ± 10.6	75.0 ± 16.7	NS
KOOS-ADL	92.3 ± 11.5	87.6 ± 15.2	NS
KOOS-Sport	78.3 ± 25.4	65.5 ± 30.8	NS
KOOS-QOL	48.8 ± 32.0	59.4 ± 24.7	NS
Pain catastrophizing	2.7 ± 2.5	5.4 ± 7.8	NS
PHQ-9	2.4 ± 3.3	3.1 ± 3.5	NS

Abbreviations: ADL, activities of daily living; BMI, body mass index; KD, knee dislocation; KOOS, Knee Injury and Osteoarthritis Outcome Score; M, male; NS, not significant; PHQ, Patient Health Questionnaire; QOL, quality of life.
[a]Values presented as mean ± standard deviation.

There were seven patients whose mechanisms of injury were not recorded in the patients' charts or disclosed by the patients in their questionnaire responses.

There were 49 KD I classified injuries, 11 KD III-L classified injuries, 10 KD III-M, 6 KD IV classified injuries, and 1 KD V classified injury. There were no injuries classified as KD II. KD I injuries were further subcategorized based on the ligaments that were injured. This information is summarized in ►**Table 1**. Additional documented injuries included 24 patients with meniscus tears (31.2%), 5 patients with KDs (6.5%), and 7 patients with chondral injuries (9.1%).

With regard to associated neurological injuries, six patients experienced peroneal nerve injuries at the time of the MLKI. Of these patients, all six patients had a foot drop requiring an ankle–foot orthosis postoperatively. Three out of the six patients (50%) with neurological injuries were noted to have a BMI above 30. Further, at follow-up, all patients still experience a certain degree of numbness within the injured foot and ankle. Two patients with associated peroneal nerve injury underwent subsequent nerve grafting procedures. One patient at 2 weeks postinjury underwent sural nerve autograft for an avulsion injury of the common peroneal nerve from the sciatic nerve. This patient did recover motor function of the peroneal nerve, although had persistent numbness at long-term follow-up. A second patient underwent nerve grafting at 8 months postinjury for a persistent foot drop with resection of a 4-cm damaged segment of the peroneal nerve at the fibular head and sural nerve autografting. This patient reported minimal motor and sensory recovery. Outcomes comparing these six patients to the 73 non-neurological injury patients are summarized in ►**Table 2**.

When controlling for age and mechanism of injury, for each 10 kg/m^2 increase in BMI, there is a 0.9-point decrease in Tegner activity scale ($p=0.001$), a 5-point decrease in KOOS-pain ($p=0.007$), a 5-point decrease in KOOS-ADL ($p=0.003$), a 10-point decrease in KOOS-QOL ($p=0.002$), and an 11-point decrease in KOOS-Sport ($p=0.002$). BMI was not associated with KOOS symptoms ($p=0.096$). There was also no significant correlation between BMI and PCS ($p=0.398$) or PHQ-9 ($p=0.484$) scores. Follow-up KOOS scores are summarized in ►**Fig. 2**.

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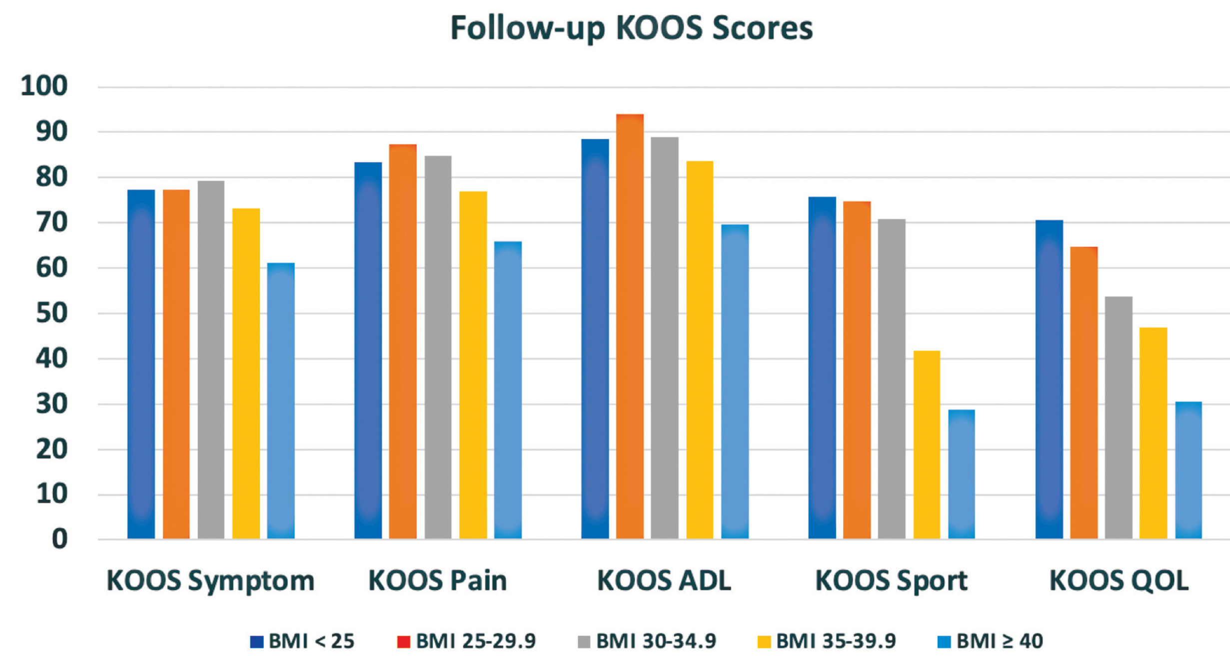

Fig. 2 Mean KOOS subgroup scores at final follow-up. ADL, activities of daily living; BMI, body mass index; KOOS, Knee Injury and Osteoarthritis Outcome Score; QOL, quality of life.

Discussion

The results indicate that when controlling for patient age and mechanism of injury, increased BMI significantly correlates with worse patient-reported outcomes at mid- to long-term follow-up after surgical repair of MLKI. The analysis reveals an inverse linear relationship between BMI and several outcome measures.

Most notably, increased BMI had the greatest negative relationship with KOOS-QOL and KOOS-Sport, with a 10- and 11-point decrease per 10 kg/m^2, respectively. This finding suggests that ability to perform more demanding physical activity and overall QOL are the outcomes most negatively impacted in patients with increased BMI. This is further supported by the reduced Tegner activity scores that were found to be associated with increased BMI. A systematic review by Everhart et al also found obese patients had significantly lower Tegner activity scores compared with nonobese patients both before injury (obese patients, 2.9 ± 1.0; general patient population, 7.6 ± 1.7; $p < 0.001$) and after injury (obese patients, 1.7 ± 1.2; general patient population, 4.5 ± 1.0; $p < 0.001$).[22] Additional outcome measures including pain, ability to perform activities of daily living, and activity level are also worse in patients with higher BMI. These are all important metrics when assessing patients' overall perceptions about the mid- to long-term outcomes of their surgical treatments.

However, the results indicate that increased BMI is not significantly associated with worse knee-related symptoms including swelling, mechanical symptoms, and range of motion as indicated by the lack of significant correlation with KOOS symptom. Similarly, Bi et al found no difference in postoperative stiffness requiring manipulation under anesthesia (MUA)/lysis of adhesions following surgery when comparing obese and nonobese patients ($p = 0.31$).[23,24] This contrasts with a study by Ridley et al that found MUA, along with failed grafts and revisions, to be less likely in obese patients.[14] BMI also does not appear to be significantly correlated with mid- to long-term mental health outcomes after surgery including symptoms of depression and pain-related anxiety.

Additionally, subgroup analysis of patients with and without nerve injuries did not demonstrate significant difference in patient-reported outcomes. Despite these patient-reported outcomes, all neurological patients experienced a degree of numbness along the foot and ankle and required an ankle–foot orthosis postoperatively. These two outcomes, especially using an ankle–foot orthosis, may make an impact on an individual's QOL. While it was not a statistically significant difference, nerve injury patients did have a KOOS-QOL score of 48.8 ± 32.0 versus non-nerve injury patients with a score of 59.4 ± 24.7. This is in accordance with Worley et al[25] found no statistically significant difference in returning to work among MLKI patients with and without associated peroneal nerve injuries. However, they noted that more than 25% of patients who did return to work were unable to return to their full duty.

Limitations

One potential caveat to note is that patients' scores from prior to their injuries were not recorded. It is unknown whether scores obtained before injury would reveal a similar correlation with BMI. Therefore, it is difficult to determine if the resulting correlation between BMI and follow-up outcome scores can be attributed solely to a difference in a patient's knee injury and surgical outcome. Additionally, a limitation to our study that should be addressed is the heterogeneity of our cohort that could result in confounders

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altering our data. While we controlled for age and mechanism of injury, other factors such as meniscal injury, chondral injury, and neurological injury could be potential confounders. This is revealed by our assessment of MLKI patients with nerve injuries having a lower KOOS-QOL score compared with a matched-cohort of patients without nerve injury. This fact leads us to a potential future study where these factors could be better controlled and assessed.

Another limitation that must be addressed centers around the assumption that surgeons' expertise and tools/techniques may have changed during our average follow-up time of 7.4 years. This introduces the bias and assumption that the negative linear relationship between BMI some clinical outcomes remain fixed. This, however, is not the case in clinical practice as surgeons typically modify their practice over time to improve different aspects of clinical outcomes. Further, controlling for this bias was difficult in our study as the patients included were not all operated on by one surgeon. So, the level of expertise and modification of operation techniques is variable.

An additional limitation of this study is the small sample size. Only 77 patients were available to complete the follow-up questionnaire, which limits the statistical power of this study. Of these 77 patients, only 6 patients who experienced a neurological injury were available to complete the follow-up questionnaire. This small number of patients severely limits the statistical power of the subgroup analysis. An additional limitation regarding the data collection is that BMI is not a static variable. BMI data in this study were collected at the time of initial presentation of the injury. Given the length of follow up ranging from 2 to nearly 16 years, patients' BMI may have increased or decreased since the time of their initial presentation. Another limitation is that follow-up was based on patient self-reported outcomes. Patients were not reexamined in a clinical setting for follow-up. Questionnaire responses can be subjective based on how each individual patient interprets the questions. Additionally, patients' willingness to respond to the questionnaire may have been influenced by their satisfaction or lack thereof with their postsurgical outcomes, potentially further biasing the results.

Conclusions

Increasing BMI has a negative linear relationship with mid- to long-term clinical outcomes including pain, ability to perform activities of daily living, QOL, and ability to perform more demanding physical activity after MLKI. BMI does not appear to have a significant relationship with knee swelling and mechanical symptoms or patients' mental health in this series of patients who underwent surgical treatment for MLKI.

Availability of Data and Material

Data are available upon request.

Compliance with Ethical Standards

This study was approved by the IRB at The Ohio State University (Study ID: 2019H0465). Given the minimal risk of the study and nature of the retrospective data review, informed consent was not required from participants. All data are presented in a deidentified manner.

Funding

None.

Conflict of interest

None declared.

References

1 Levy BA, Fanelli GC, Whelan DB, et al; Knee Dislocation Study Group. Controversies in the treatment of knee dislocations and multiligament reconstruction. J Am Acad Orthop Surg 2009;17 (04):197–206
2 Fanelli GC, Orcutt DR, Edson CJ. The multiple-ligament injured knee: evaluation, treatment, and results. Arthroscopy 2005;21 (04):471–486
3 Jenkins PJ, Clifton R, Gillespie GN, Will EM, Keating JF. Strength and function recovery after multiple-ligament reconstruction of the knee. Injury 2011;42(12):1426–1429
4 Peskun CJ, Whelan DB. Outcomes of operative and nonoperative treatment of multiligament knee injuries: an evidence-based review. Sports Med Arthrosc Rev 2011;19(02):167–173
5 Richter M, Bosch U, Wippermann B, Hofmann A, Krettek C. Comparison of surgical repair or reconstruction of the cruciate ligaments versus nonsurgical treatment in patients with traumatic knee dislocations. Am J Sports Med 2002;30(05):718–727
6 Lynch AD, Chmielewski T, Bailey L, et al; STaR Trial Investigators. Current concepts and controversies in rehabilitation after surgery for multiple ligament knee injury. Curr Rev Musculoskelet Med 2017;10(03):328–345
7 Peltola EK, Lindahl J, Hietaranta H, Koskinen SK. Knee dislocation in overweight patients. AJR Am J Roentgenol 2009;192(01): 101–106
8 Georgiadis AG, Mohammad FH, Mizerik KT, Nypaver TJ, Shepard AD. Changing presentation of knee dislocation and vascular injury from high-energy trauma to low-energy falls in the morbidly obese. J Vasc Surg 2013;57(05):1196–1203
9 Azar FM, Brandt JC, Miller RH III, Phillips BB. Ultra-low-velocity knee dislocations. Am J Sports Med 2011;39(10):2170–2174
10 Stewart RJ, Landy DC, Khazai RS, Cohen JB, Ho SS, Dirschl DR. Association of injury energy level and neurovascular injury following knee dislocation. J Orthop Trauma 2018;32(11):579–584
11 Lian J, Patel NK, Nickoli M, et al. Obesity is associated with significant morbidity after multiligament knee surgery. J Knee Surg 2020;33(06):525–530
12 Johnson JP, Kleiner J, Klinge SA, McClure PK, Hayda RA, Born CT. Increased incidence of vascular injury in obese patients with knee dislocations. J Orthop Trauma 2018;32(02):82–87
13 Werner BC, Gwathmey FW Jr, Higgins ST, Hart JM, Miller MD. Ultra-low velocity knee dislocations: patient characteristics, complications, and outcomes. Am J Sports Med 2014;42(02): 358–363
14 Ridley TJ, Cook S, Bollier M, et al. Effect of body mass index on patients with multiligamentous knee injuries. Arthroscopy 2014; 30(11):1447–1452
15 Vaidya R, Roth M, Nanavati D, Prince M, Sethi A. Low-velocity knee dislocations in obese and morbidly obese patients. Orthop J Sports Med 2015;3(04):2325967115575719
16 Cook S, Ridley TJ, McCarthy MA, et al. Surgical treatment of multiligament knee injuries. Knee Surg Sports Traumatol Arthrosc 2015;23(10):2983–2991
17 Hagino RT, DeCaprio JD, Valentine RJ, Clagett GP, Snyder J. Spontaneous popliteal vascular injury in the morbidly obese. J Vasc Surg 1998;28(03):458–462, discussion 462–463

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18 Peskun CJ, Chahal J, Steinfeld ZY, Whelan DB. Risk factors for peroneal nerve injury and recovery in knee dislocation. Clin Orthop Relat Res 2012;470(03):774–778

19 Sanders TL, Johnson NR, Levy NM, et al. Effect of vascular injury on functional outcome in knees with multi-ligament injury: a matched-cohort analysis. J Bone Joint Surg Am 2017;99(18): 1565–1571

20 Hanley J, Westermann R, Cook S, et al. Factors associated with knee stiffness following surgical management of multiligament knee injuries. J Knee Surg 2017;30(06):549–554

21 Goebel CP, Domes C. Classifications in brief: the Schenck classification of knee dislocations. Clin Orthop Relat Res 2020;478(06): 1368–1372

22 Everhart JS, Du A, Chalasani R, Kirven JC, Magnussen RA, Flanigan DC. Return to work or sport after multiligament knee injury: a systematic review of 21 studies and 524 patients. Arthroscopy 2018;34(05):1708–1716

23 Wright RW. Knee injury outcomes measures. J Am Acad Orthop Surg 2009;17(01):31–39

24 Bi AS, Mojica ES, Markus DH, et al. Risk of postoperative stiffness following multiligamentous knee injury surgery is not affected by obesity: a multicenter study. Arthroscopy 2022;38(12):3175–3181

25 Worley JR, Brimmo O, Nuelle CW, Cook JL, Stannard JP. Incidence of concurrent peroneal nerve injury in multiligament knee injuries and outcomes after knee reconstruction. J Knee Surg 2019;32 (06):560–564

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