Systematic Review

Greater Detail Is Needed When Reporting Schenck Knee Dislocation V Injuries in the Orthopaedic Literature: A Systematic Review

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Purpose: To examine how knee dislocations (KDs) with associated periarticular fractures classified using the Schenck KD V subcategory are reported in the literature. **Methods:** PubMed, Cumulative Index to Nursing and Allied Health Literature, and Scopus were queried in January 2024. Studies were included if full-text articles in English were available, the Schenck KD classification system was used, and Schenck KD class V was mentioned. The exclusion criteria were as follows: studies in which the Schenck KD classification system was used but only KD classes I to IV were mentioned; systematic reviews, meta-analyses, review articles, commentaries, surgical technique articles, or animal studies; or studies in which pediatric patients were included. Studies were systematically examined for details regarding the descriptions of KD V injuries, including fracture and ligament tear patterns. **Results:** Seventy-four studies met the inclusion criteria. Of these 74 studies, 45 (60.8%) provided no description of either the ligament tear or fracture patterns that were present in KD V injuries. Fifty-two studies (70.3%) provided no description of the ligament tear patterns and 51 studies (68.9%) provided no description of the fracture patterns associated with KD V injuries. Only 16 of 74 studies (21.6%) included descriptions of ligament tear patterns and fractures present in KD V injuries. **Conclusions:** Descriptions of Schenck KD class V are poorly represented in the orthopaedic literature. **Level of Evidence:** Level IV, systematic review of Level II to IV studies.

Knee fracture-dislocations are characterized by total disruption of the tibiofemoral joint with an associated periarticular fracture that contributes to joint instability and implies increased neurovascular risk as compared with an isolated periarticular fracture of the knee.[1] Various classification systems have been proposed for categorizing knee dislocations (KDs). In 1994, Schenck[2] established an anatomic classification system based on the associated ligament tear patterns, which allowed for improved communication of injury severity and helped guide treatment. In 1997, the Schenck classification system was modified by Wascher et al.[3] to include KD V injury, defined as a KD with a periarticular fracture (Appendix Table 1). The modified Schenck classification system has become the most widely used method for categorizing KDs.[4]

KD V injuries are a unique type of KD in that they are characterized by both ligament tear patterns and fracture patterns. The nondescript phrase of a "knee-dislocation with periarticular fracture" has been used in the past; however, no universally agreed on definition has been established for a fracture-dislocation and which patterns of injury represent a periarticular fracture.[1,5] A systematic approach to delineate ligament tear patterns within KD V injuries was published by Stannard et al.[6] in 2004 (Table 1). Existing fracture classifications such as those of Moore[7] and Schatzker et al.[8] have been used in the literature; however, these are limited to tibial plateau fractures (TPFs) and exclude other periarticular fractures that may constitute KD V injuries.

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Table 1. Fracture Patterns Reaching Positive Consensus for Inclusion in KD V Subcategory by Medvecky et al.[1]

1. Displaced articular fracture of distal femur
2. Nondisplaced articular fracture of distal femur
3. TPF with weight-bearing surface involvement, with or without tibial spine involvement
4. Tibial plateau peripheral rim compression fracture
5. Posterolateral tibial plateau compression fracture, Bernholt type IIB injury
6. Posterolateral tibial plateau compression fracture, Bernholt type IIIA injury
7. Posterolateral tibial plateau compression fracture, Bernholt type IIIB injury
8. Gerdy tubercle avulsion fracture with weight-bearing surface involvement
9. Displaced tibial tubercle fracture
10. Displaced patellar body fracture
11. Displaced inferior patellar pole fracture

KD, knee dislocation; TPF, tibial plateau fracture.

Discussion of KD V injuries without designation of the ligament tear patterns and fracture patterns present has become commonplace in the orthopaedic literature. Greater detail regarding KD class V is needed to improve communication among providers, guide clinical and surgical planning, improve future research, and aid in patient counseling. Despite clinical expertise, there is no clear consensus on what constitutes a knee fracture-dislocation. This may skew our understanding of the clinical outcomes for these complex injuries.

The purpose of this systematic review was to examine how KDs with associated periarticular fractures classified using the Schenck KD V subcategory are reported in the literature. We hypothesized that unclear reporting of Schenck KD class V would illustrate the need for a more detailed and standardized approach for characterizing these complex knee injuries.

Methods

This systematic review was conducted in accordance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-analyses statement. Two reviewers (A.J.M., S.L.) conducted the systematic review independently, and a third reviewer (J.S.G.) was consulted to resolve any disagreements.

Search Strategy

The protocol for the systematic review was established prior to the initiation of the search. A systematic literature search was conducted in PubMed, Cumulative Index to Nursing and Allied Health Literature, and Scopus with no language restrictions and a filter setting the period to 1997-2024. This period was chosen because the KD V subcategory was added to the Schenck KD classification system in 1997 by Wascher et al.[3] The initial search was conducted on January 24, 2024, by 1 author (A.J.M.). The search was repeated on January 25, 2024, by a different author (S.L.) and yielded the same results. The search was repeated for the final time on May 5, 2024, and any new publications that met the inclusion criteria of this study were added to the analysis. The search query was conducted using various combinations of the following terms: Knee dislocation, Multiligament knee injury, Periarticular fracture, Schenck classification, and KD V.

Study Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: (1) full-text articles in English were available; (2) the Schenck KD classification system was used to describe KDs or multiligament knee injuries; and (3) Schenck KD class V was mentioned. The exclusion criteria were as follows: (1) the Schenck KD classification system was used but only mentioned KD classes I to IV; (2) the study was a systematic review, meta-analysis, review article, commentary, surgical technique article, or animal study; and (3) pediatric patients were included. Two reviewers (A.J.M., S.L.) independently conducted the study selection based on the inclusion and exclusion criteria. A third reviewer (J.S.G.) was consulted to resolve any disagreements.

Data Extraction

The following items were extracted from all included studies: first author name, publication year, country in which the investigation was performed, level of evidence, definition used for KD V, number of KD V patients included in the study, whether the study used the Stannard subclassification for KD V, ligament tear patterns associated with KD V injuries, and information regarding the types of fractures included in the KD V subcategory. Data were collected independently by 2 authors (A.J.M., S.L.), referencing a third author (J.S.G.) for discrepancies and disagreements.

Risk of Bias

Quality assessment of the included studies was performed using the Methodological Index for Non-randomized Studies (MINORS) checklist.[9] This quality assessment tool has been widely used in the literature and is a reliable scoring system for the risk of bias in noncomparative and comparative studies.[9] The Methodological Index for Non-randomized Studies tool uses a 12-item checklist. Each item is scored on a scale of 0 to 2. For both noncomparative and comparative studies, a score of 0 indicates "not reported," a score of 1 indicates "reported but inadequate," and a score of 2 indicates "reported and adequate." The maximum score for a noncomparative study is 16, whereas the maximum score for a comparative study is 24. A score

of 0 to 5 indicates very low quality; 6 to 9, low quality; 10 to 14, fair quality; and 15 or greater, good quality.

Results

Search Results

The search query on PubMed, Cumulative Index to Nursing and Allied Health Literature, and Scopus yielded a pooled result of 13,571 articles. After duplicate articles were removed, 6,235 articles were screened. Of these articles, 5,620 were excluded based on the study title and abstract. Of the 615 studies remaining, 74 were eligible for inclusion in the systematic review and further analysis (Fig 1). Characteristics of the included studies are summarized in Appendix Table 2.

Descriptions of Schenck KD V Injuries

Of the 74 included studies, 45 (60.8%) provided no description of ligament tear or fracture patterns present in KD V injuries. These studies either provided no explicit definition of KD V or defined KD V as a "knee dislocation with a periarticular fracture" (or used a similar definition). Of the 74 studies, 6 (8.1%) delineated ligament tear patterns within KD V injuries either by using the Stannard subclassification system or by listing the injured ligaments but did not include descriptions of associated fractures. Seven of 74 studies (9.5%) did not delineate ligament tear patterns but did provide descriptions of fractures present within KD V injuries. Of the 74 included studies, 16 (21.6%) included descriptions of both ligament tear patterns and fracture patterns present within KD V injuries. In 51 of 74 studies (68.9%) that reported KD V injuries, a total of 723 patients were accounted for, with the largest cohort comprising 101 patients.[10] Twenty-three of 74 studies (31.1%) did not report any KD V patients. A summary of the spectrum of KD V injury descriptions is included in Figure 2.

To delineate the ligament tear patterns associated with KD V injuries, only 6 of 74 studies (8.1%) used the

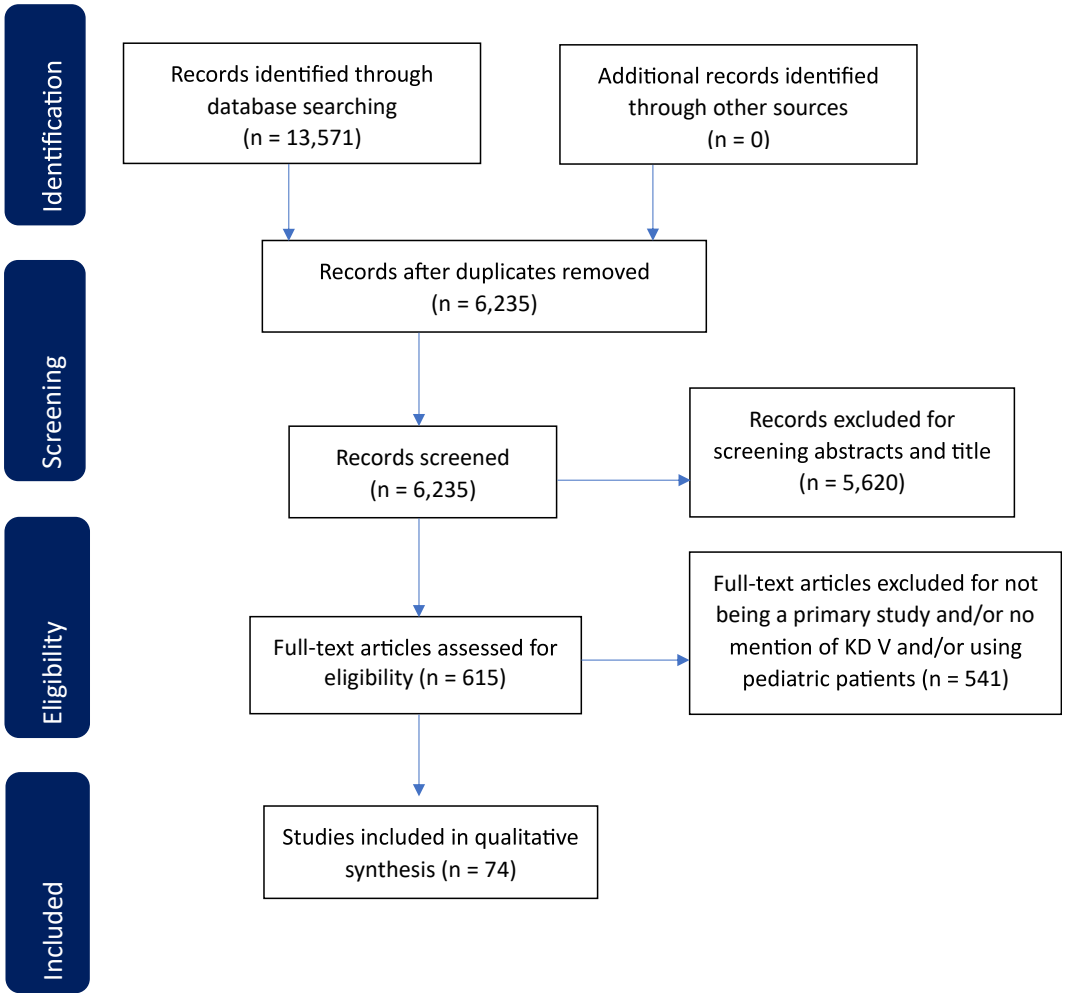

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses flowchart for literature screening. (KD, knee dislocation.)

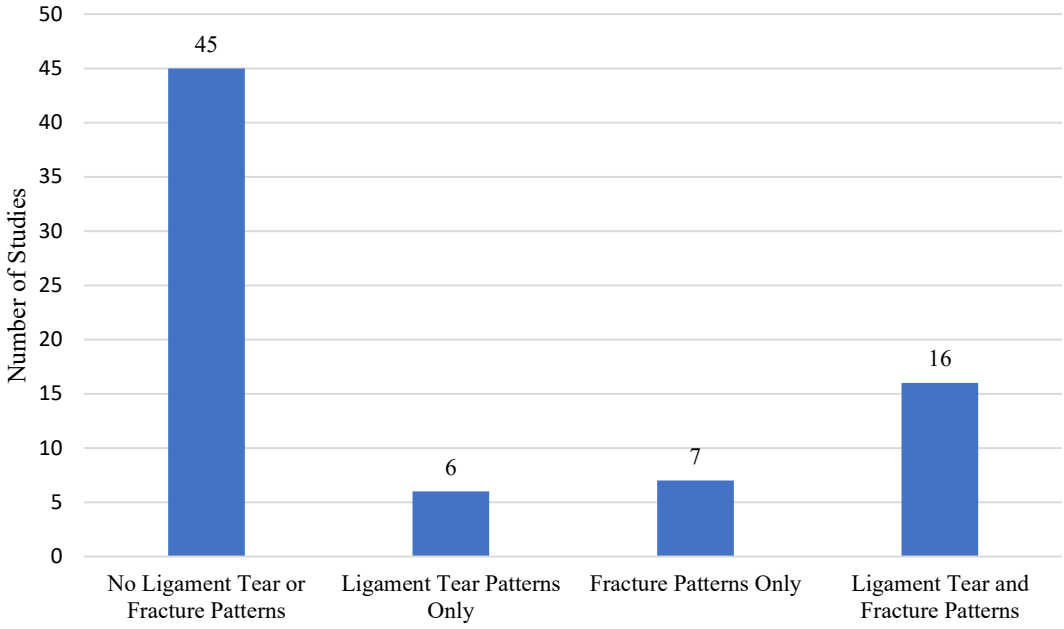

Fig 2. Spectrum of knee dislocation (KD) class V injury descriptions provided by included studies.

Stannard subclassification system. Sixteen of 74 studies (21.6%) listed the ligament tear patterns present in KD V injuries without the use of the Stannard subclassification system. Of the 74 included studies, 52 (70.3%) offered no description of ligament tear patterns present within KD V injuries. Seventy-three of 74 studies (98.6%) were published after the Stannard modification was established in 2004. The methods used for delineating ligament tear patterns present within KD V injuries are summarized in Figure 3.

The fracture patterns considered to be KD V injuries were described in 23 of the 74 included studies (31.1%). Of the 74 included studies, 51 (68.9%) did not provide any descriptions of the fracture patterns associated with KD V injuries.

Of the 24 studies that included specific descriptions of the fracture patterns present within KD V injuries, 12 (50.0%) included TPFs, 6 (25.0%) included femoral condyle fractures, 6 (25.0%) included tibial avulsion fractures, 6 (25.0%) included fibular head fractures, 2 (8.3%) included patellar fractures, 1 (4.2%) included vastus medialis avulsion fractures, and 1 (4.2%) described nonspecific medial tibial fractures. Of the studies that described TPFs, 9 of 13 (69.2%) did not use an established classification system, 3 of 13 (23.1%) used the Schatzker classification system, and 1 of 13 (7.7%) used the Moore classification system. Each of the 6 studies describing tibial avulsion fractures included the following different fracture patterns: lateral tibial plateau avulsion, medial tibial plateau avulsion, posterior cruciate ligament avulsion, Segond fracture, tibial spine avulsion, and tibial tubercle avulsion. Two studies (8.3%) provided the following nonspecific fracture descriptions: (1) fractures of the medial or lateral compartment of the knee and (2) fractures involving the bony block connected to at least 1 major ligament. Two studies (8.3%) were unclear regarding which fractures were considered KD V injuries. Fibular head, patellar inferior pole, lateral collateral ligament avulsion, medial collateral ligament avulsion, and posterior cruciate ligament avulsion fractures were described by Chun et al.[11] It was not specified which of these fractures were included in KD class V. Thirty-nine KD V patients were described by Stannard et al.,[6] 38 of whom had TPFs. They also described 1 patient with a supracondylar femoral fracture and 1 patient with a patellar fracture. It is unclear which of these patients was also considered to have a KD V injury. A pie chart of the fracture patterns that the included studies considered to be within the KD V subcategory is illustrated in Figure 4.

Discussion

The most important finding of this study was that the current literature shows a clear lack of specificity regarding the descriptions of ligament tear patterns and fracture patterns within Schenck KD class V. Of the 74 reviewed studies, 45 (60.8%) included no description of ligament tear patterns or fracture patterns present within KD V injuries. Furthermore, 52 of 74 (70.3%) did not delineate ligament tear patterns and 51 of 74 (68.9%) did not describe the fracture patterns within KD V injuries. Only 16 of 74 studies (21.6%) provided both ligament tear patterns and fracture patterns in KD V injuries. These findings emphasize the need for greater detail when reporting KD V injuries to improve

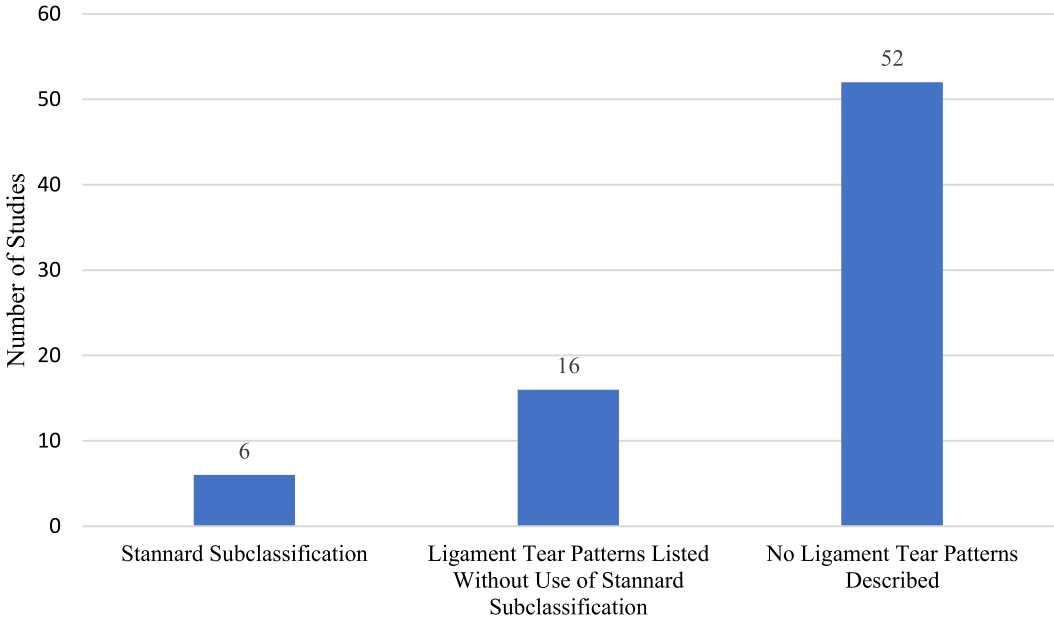

Fig 3. Method of delineating ligament tear patterns in knee dislocation (KD) class V injuries used by included studies.

communication among providers, enhance understanding of clinical outcomes, and better guide clinical management.

The Stannard modification of KD class V established a systematic approach to delineating ligament tear patterns associated with knee fracture-dislocations.[6] However, only 5 other studies have used this system since it was published in 2004.[12-16] All 16 studies that listed the ligament tear patterns without the modifying suffix were published after the Stannard modification.[17-32] Only 1 of the included 74 studies was published prior to 2004.[33] Therefore, 67 studies that were able to use the Stannard subclassification system did not use this system.[10,11,17-32,34-82]

Understanding ligamentous involvement within KDs is crucial to clinical management and surgical planning and may factor into the risk assessment for concomitant neurovascular injury. The most commonly injured vascular structure in the setting of a KD is the popliteal artery, with an overall incidence of 10.7%.[83] The most commonly injured nerve structure is the common peroneal nerve, with an incidence of 19.2%.[84] The incidence of neurovascular injury was shown to be significantly more prevalent in bicruciate versus unicruciate injuries in a meta-analysis by Green et al.[46] However, this study included only KD I to IV injuries. Few studies have examined differences in neurovascular injury with varying ligament tear patterns in KD V injuries.[12,16,19,29,30,32] Most of the patients in these studies showed neurovascular injury with bicruciate injuries. Although the incidence of neurovascular injury is likely to vary across different fracture patterns in KD V injuries, we are not aware of any study that has examined this. The potential for increased neurovascular injury with more severe KD V injuries highlights the importance of distinguishing the ligament tear and fracture patterns present. Future research may address this gap in the orthopaedic literature.

There is little consensus on the specific periarticular fracture patterns that should be included in KD class V.[1,5] For instance, 6 studies included fibular head fractures as the qualifying element for inclusion in the KD V subcategory,[19,20,22,28,38,56] whereas 2 other studies described fibular head fractures as non−KD V injuries.[16,26] Additionally, 1 study mentioned a fibular head fracture but was unclear regarding whether this constituted a label of KD V.[11] Fractures of the tibial plateau or femoral condyle are less likely to vary in whether they are included in KD class V given that these fractures typically involve larger areas of the articular surfaces and may contribute more significantly to tibiofemoral instability. Furthermore, these fractures were described in the primary publication that established the KD V subcategory.[3] All studies that described KDs with TPFs or femoral condylar fractures did so within the context of a KD V injury.[6,16,17,21,22,25,26,28-30,38,53,77,82]

A study published in 2023 used the Delphi method in an attempt to establish consensus on which types of fractures should be included in the KD V subcategory.[1,85] This study suggested that KD V qualifying fractures are those that contribute significantly to tibiofemoral joint instability and significantly impact surgical management. Broadly, this includes fractures

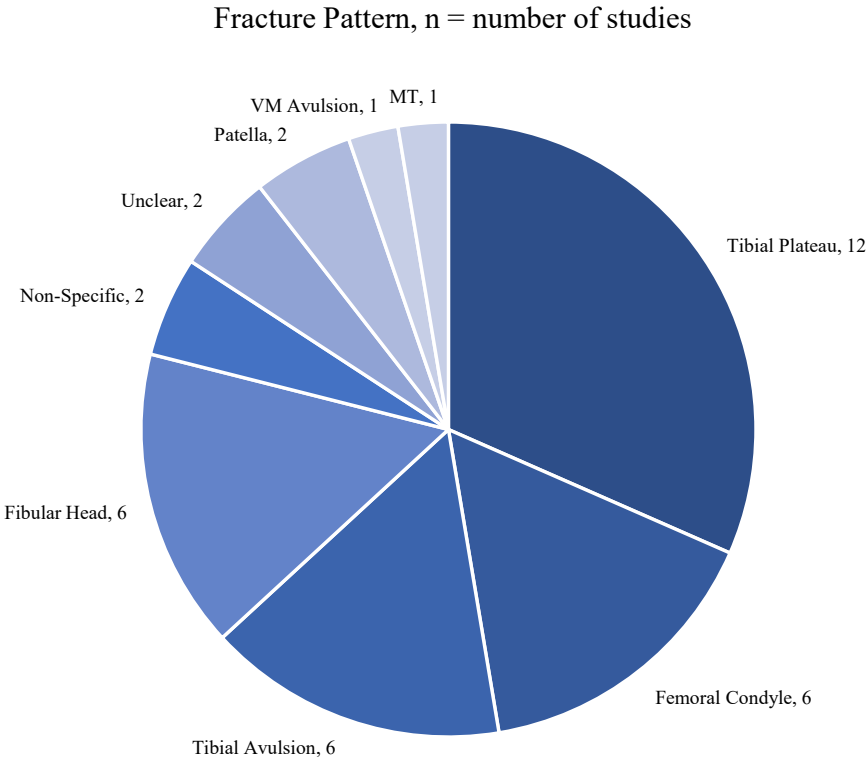

Fig 4. Fracture patterns that included studies considered to be within knee dislocation (KD) V subcategory. (MT, medial tibial; VM, vastus medialis.)

of the tibiofemoral articular surfaces, as well as displaced fractures requiring internal fixation and potential soft-tissue reconstruction or repair.[1] The fracture patterns that reached positive consensus in this study can be found in Table 1. Fractures that achieved consensus for exclusion from KD class V include the following: Bernholt type I and IIA injuries, avulsion fractures, nondisplaced patellar body and inferior pole fractures, nondisplaced tibial tubercle fractures, and proximal fibular fractures. Although this study does not establish standardized criteria for selecting the fracture types included in KD class V, it demonstrates the notion that the fracture component of a KD V injury should contribute significantly to the instability of the tibiofemoral joint. Of the included studies, 11 described KD V injuries with fracture patterns that reached negative consensus in the recent Delphi study.[14,15,17,19-22,28,32,38,56] These fractures include proximal fibular fractures, various avulsion fractures, non−weight-bearing or non−articular surface fractures, and potentially nondisplaced patellar fractures. Therefore, KD V injuries may be misrepresented in the current literature if these injuries are indeed not to be included in KD class V.

Our study corroborates the need for greater detail regarding the fracture patterns included in KD class V. A concomitant fracture contributing to the instability of a KD has a significant impact on surgical planning and the ability to reconstruct or repair ligamentous injuries.[1,3,5,15] For example, after stabilization of neurovascular injury, unstable fracture-dislocations may require early open reduction and internal fixation and/or immobilization with a knee-spanning external fixator, with subsequent staged reconstruction or repair of soft-tissue injuries.[5,15,86,87] Alternatively, certain avulsion fractures often have similar mechanisms of injury to intrasubstance tears and may not contribute to joint instability.[1,88]

When feasible, characterization of Schenck KD V injuries should include descriptions of both ligament tear patterns and fracture patterns. When applicable, researchers and clinicians should use established subclassification systems to modify Schenck KD class V. Use of the Stannard subclassification system has been minimal since its establishment in 2004.[6] Systematic approaches to fracture patterns are more difficult, given the heterogeneous nature of fracture presentations. However, subclassification systems such as those of Schatzker et al.,[8] Moore,[7] Hohl and Luck,[89] and Bernholt et al.[90] for TPFs and Seinsheimer[91] for femoral condylar fractures should be used when possible, or precise descriptors of fractures should be included. Increased detail when describing KD V injuries will improve communication among providers, improve future research methodology, and help establish more injury-specific treatment algorithms for fracture-dislocations. Future research may strive to establish a

standardized classification system specific for KD V injuries with an eye toward specific treatment recommendations.

Limitations

This study is not without limitations. This systematic review included only studies that used the Schenck classification system for KDs. Therefore, studies that described injuries consistent with fracture-dislocations but did not classify them as Schenck KD V injuries were excluded. Moreover, the Schenck KD V subcategory may not capture all possible variations of KDs and has not been evaluated for interobserver or intraobserver reliability. Additionally, there were multiple studies included from the same institution.[1,10,26,31,80,81] As a result, the same patients may have been accounted for multiple times. This study was further limited by the inherent nature of the issue that was addressed (i.e., the lack of detail in describing KD V injuries). In some instances, vague descriptions of KD V injuries made for an imperfect analysis.

Conclusions

Descriptions of Schenck KD class V are poorly represented in the orthopaedic literature.

Disclosures

All authors (A.J.M., S.L., J.S.G., J.M., P.J., R.C.S., D.C.W., M.J.A., M.J.M.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Appendix Table 1. Modified Schenck Classification System for KDs With Addition of Stannard Subclassification for KD V Injuries

	Definition
Schenck KD subcategory	
KD I	Dislocation with disruption of 1 cruciate ligament (ACL or PCL)
KD II	Dislocation with disruption of both cruciate ligaments (ACL + PCL)
KD IIIM	Dislocation with disruption of both cruciate ligaments (ACL + PCL) and MCL
KD IIIL	Dislocation with disruption of both cruciate ligaments (ACL + PCL) and LCL
KD IV	Dislocation with disruption of both cruciate ligaments (ACL + PCL) and both collateral ligaments (MCL + LCL)
Stannard modification of KD V	Dislocation with periarticular fracture
KD V.1	KD V with disruption of 1 cruciate ligament (ACL or PCL)
KD V.2	KD V with disruption of both cruciate ligaments (ACL + PCL)
KD V.3M	KD V with disruption of both cruciate ligaments (ACL + PCL) and MCL
KD V.3L	KD V with disruption of both cruciate ligaments (ACL + PCL) and LCL
KD V.4	KD V with disruption of both cruciate ligaments (ACL + PCL) and both collateral ligaments (MCL + LCL)

ACL, anterior cruciate ligament; KD, knee dislocation; LCL, lateral collateral ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament.

Appendix Table 2. Study Characteristics

Authors (Date)	Country	LOE	KD V Definition	No. of KD V Patients	Stannard Modification (Y or N)	Ligaments Described* (Y or N)	Fractures Described (Y or N)	MINORS Score
Allen et al.[34] (2015)	United States	III	Not reported	7	N	N	N	17 of 24
Amar et al.[36] (2010)	Morocco	IV	KD with periarticular fracture	0	N	N	N	7 of 16
Angan et al.[35] (2023)	Ireland	IV	KD and fracture association	0	N	N	N	7 of 16
Atinga et al.[12] (2022)	Canada	III	Intra-articular fracture and injury of at least 1 knee ligament in patients with clinically suspected KD	80	Y		N	21 of 24
Aydın et al.[37] (2013)	Turkey	IV	KD associated with periarticular fracture	0	N	N	N	8 of 16
Bernardi et al.[17] (2021)	Italy	IV	Not reported	1	N	Y	Y	7 of 16
Bi et al.[38] (2022)	United States	III	Not reported	36	N	N	Y	23 of 24
Billières et al.[39] (2020)	France	IV	Periarticular fracture-dislocation	0	N	N	N	13 of 16
Boos et al.[18] (2024)	United States	IV	Fracture-dislocation	1	N	Y	N	16 of 16
Born et al.[40] (2014)	United States	III	Fracture-dislocation	12	N	N	N	16 of 16
Bui et al.[41] (2006)	United States	IV	Dislocation with associated periarticular fracture	0	N	N	N	7 of 16
Burton et al.[42] (2020)	United Kingdom	III	Not reported	2	N	N	N	18 of 24
Chahal et al.[13] (2014)	United States	II	KD associated with fracture	0	Y		N	16 of 16
Chew et al.[14] (2022)	United Kingdom	IV	Fracture-dislocation	1	Y		Y	7 of 16
Chun et al.[11] (2023)	Republic of Korea	IV	Periarticular fracture/ dislocation	0	N	N	N	10 of 16
Darabos et al.[15] (2013)	Croatia	IV	Not reported	3	Y		Y	12 of 16
Djebara and Pujol[43] (2022)	France	IV	Fracture-dislocation	0	N	N	N	13 of 16
Engebretsen et al.[44] (2009)	Norway	IV	Not reported	0	N	N	N	15 of 16
Freychet et al.[45] (2020)	United States	III	Not reported	2	N	N	N	18 of 24
Green et al.[46] (2023)	United States	IV	Fracture-dislocation	0	N	N	N	16 of 16
Gregersen and Freund[19] (2022)	Denmark	IV	Fracture-dislocation	3	N	Y	Y	8 of 16
Held et al.[47] (2021)	United States	IV	Not reported	1	N	N	Y	12 of 16
Hirschmann et al.[48] (2010)	Switzerland	IV	Multiligamentous injury with periarticular fracture	0	N	N	N	8 of 16
Hoit et al.[49] (2021)	Canada	II	Not reported	0	N	N	N	22 of 24
Holuba et al.[20] (2023)	United States	IV	Not reported	1	N	Y	Y	8 of 16
Hughes et al.[50] (2020)	United States	IV	Not reported	4	N	N	N	11 of 16
Jacobs et al.[51] (2023)	United States	III	Fracture-dislocation	0	N	N	N	20 of 24
Jokela et al.[52] (2021)	Finland	IV	Fracture-dislocation	6	N	N	N	14 of 16
Kahan et al.[82] (2021)	United States	IV	Fracture-dislocation	15	N	Y	Y	16 of 16
Kanakamedala et al.[21] (2020)	United States	III	Not reported	6	N	Y	Y	19 of 24
Kilicoglu et al.[53] (2021)	Turkey	IV	Not reported	3	N	N	Y	12 of 16
Korber et al.[55] (2024)	United States	III	Not reported	2	N	N	N	21 of 24
Kolosky et al.[54] (2018)	United States	IV	Multiligamentous injury with periarticular fracture	0	N	N	N	8 of 16
Kosy et al.[56] (2018)	United Kingdom	IV	Multiligament injury with associated fracture	80	N	N	Y	9 of 16
Krych et al.[57] (2014)	United States	III	Not reported	4	N	N	N	18 of 24
Kupczik et al.[16] (2013)	Brazil	IV	Fracture-dislocation	6	Y		Y	8 of 16
Lee et al.[22] (2022)	United States	IV	KD IV with associated periarticular fracture	7	N	Y	Y	10 of 16
Levy et al.[58] (2015)	United States	IV	Not reported	2	N	N	N	10 of 16
Li et al.[59] (2023)	China	IV	Not reported	0	N	N	N	10 of 16
Li et al.[60] (2021)	China	II	Fracture-dislocation	10	N	N	Y	23 of 24
Li et al.[23] (2022)	China	IV	Any KD classification accompanied by periarticular fracture orKD	21	N	Y	N	10 of 16

(continued)

Appendix Table 2. Continued

Authors (Date)	Country	LOE	KD V Definition	No. of KD V Patients	Stannard Modification (Y or N)	Ligaments Described* (Y or N)	Fractures Described (Y or N)	MINORS Score
Li et al.[24] (2024)	United States	IV	Not reported	5	N	Y	N	16 of 16
Marwan et al.[25] (2018)	Canada	IV	Multiligamentous injury with periarticular fracture	9	N	Y	Y	10 of 16
Maxwell et al.[61] (2021)	United States	IV	Any MLKI with periarticular fracture	91	N	N	N	8 of 16
Moatshe et al.[62] (2017)	Norway	III	Fracture-dislocation	0	N	N	N	21 of 24
Mojica et al.[63] (2023)	United States	IV	Not reported	6	N	N	N	16 of 16
Molund et al.[64] (2014)	Norway	IV	KD with severe intra-articular fracture	0	N	N	N	15 of 16
Moran et al.[26] (2022)	United States	IV	MLKI with periarticular fracture	2	N	Y	Y	16 of 16
Moreno et al.[65] (2022)	Portugal	IV	Multiligamentous injury with periarticular fracture	0	N	N	N	8 of 16
Neri et al.[66] (2019)	Australia	III	Not reported	13	N	N	N	17 of 24
Nicandri et al.[67] (2010)	United States	III	Dislocation associated with periarticular fracture and multiple ligament injury	7	N	N	N	18 of 24
Otto et al.[27] (2020)	Germany	IV	Not reported	1	N	Y	Y	11 of 16
Owens et al.[28] (2007)	United States	IV	Not reported	9	N	Y	Y	13 of 16
Paterson-Byrne et al.[68] (2022)	Scotland	IV	Associated periarticular fracture	0	N	N	N	8 of 16
Peskun et al.[69] (2012)	Canada	II	Not reported	0	N	N	N	12 of 16
Poploski et al.[70] (2023)	United States	IV	KD with associated periarticular fracture	0	N	N	N	8 of 16
Reverté-Vinaixa et al. [29] (2023)	Spain	IV	Fracture-dislocation	6	N	Y	Y	12 of 16
Said et al.[71] (2023)	Denmark	IV	Multiligament injury with periarticular fracture	0	N	N	N	14 of 16
Sanders et al.[30] (2017)	United States	III	Not reported	3	N	Y	Y	17 of 24
Sanders et al.[72] (2018)	United States	IV	Not reported	5	N	N	N	11 of 16
Schenck et al.[73] (2014)	United States	IV	Fracture-dislocation	0	N	N	N	10 of 16
Scheu et al.[74] (2020)	Chile	IV	ACL + PCL + LCL + MCL + periarticular fracture	2	N	Y	N	10 of 16
Shamrock et al.[75] (2022)	United States	IV	Not reported	8	N	N	N	9 of 16
Sharma et al.[76] (2016)	India	IV	Not reported	2	N	Y	Y	8 of 16
Stannard et al.[33] (2002)	United States	III	KD with periarticular fracture	20	N	N	N	22 of 24
Stannard et al.[77] (2012)	United States	III	Not reported	13	N	N	Y	22 of 24
Stannard et al.[6] (2004)	United States	IV	Dislocation associated with periarticular fracture and multiple-ligament injury	39	Y		Y	13 of 16
Whelan et al.[78] (2014)	Canada	III	Fracture-dislocation	6	N	N	N	23 of 24
Woodmass et al.[79] (2018)	United States	III	Not reported	4	N	N	N	21 of 24
Woodmass et al.[31] (2018)	United States	IV	MLKI with periarticular fracture	1	N	Y	N	23 of 24
Woodmass et al.[80] (2018)	United States	IV	Not reported	1	N	N	N	16 of 16
Worley et al.[81] (2022)	United States	IV	Not reported	58	N	N	N	16 of 16
Worley et al.[10] (2019)	United States	III	Not reported	101	N	N	N	19 of 24
Xu et al.[32] (2018)	China	IV	Not reported	1	N	Y	Y	9 of 16

ACL, anterior cruciate ligament; KD, knee dislocation; LCL, lateral collateral ligament; LOE, level of evidence; MCL, medial collateral ligament; MINORS, Methodological Index for Non-randomized Studies; MLKI, multi-ligament knee injury; N, no; PCL, posterior cruciate ligament; Y, yes.
*Ligaments described without use of Stannard modification.