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Operative treatment of Lisfranc injuries in elite athletes: 2024 international foot and ankle sports consensus and systematic review

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Abstract

Purpose: Lisfranc injuries are potentially career-threatening for athletes, yet optimal management of unstable ligament and fracture-dislocation injury patterns remains debated. This study integrates an international expert consensus with a systematic review to evaluate current surgical strategies and outcomes, aiming to establish evidence-based recommendations for the treatment of elite athletes and to optimize recovery and return to play.

Methods: A systematic review evaluated post-operative outcomes following suture button fixation (SBF), open reduction internal fixation (ORIF) and arthrodesis of unstable ligament and fracture-dislocation Lisfranc injuries. In addition, a consensus process was conducted using a modified Delphi technique. All consensus questions were generated by an initial survey sent to the expert panel. General consensus was defined as 75%–85% agreement, strong consensus as 86%–99% agreement and unanimous consensus as 100% agreement.

Results: Sixteen studies ($n = 406$ athletes) were included. In the unstable ligament group, SBF ($n = 46$) versus ORIF ($n = 203$) yielded higher American Orthopaedic Foot and Ankle Society (95.5 vs. 89.4), lower complications (10.9% vs. 18.2%), zero failures (0% vs. 4.9%) and fewer secondary procedures (0% vs. 30.5%), with 93.5% of ORIF reoperations being hardware removal. In fracture-dislocation injury patterns, ORIF ($n = 123$) and arthrodesis ($n = 31$) showed similar complication (30.8% vs. 35.5%) and failure rates (13.8% vs. 12.9%), with secondary procedures more frequent after ORIF (90.2% vs. 22.6%). The consensus process generated 16 statements: 12 achieved unanimous agreement and 4 achieved strong consensus.

Conclusion: Elite athletes who present with unstable ligament Lisfranc injuries and indications for surgical intervention should undergo fixation

Abbreviations: CT, computed tomography; IFASC, International Foot and Ankle Sports Consensus; JBI, Joanna Briggs Institute; LOE, level of evidence; M/F, male/female; MINORS, Methodological Index for Non-Randomized Studies; mo, months; MRI, magnetic resonance imaging; N/E, not able to be extracted; N/R, not recorded; N, number; NCAA, National Collegiate Athletics Association; ORIF, open reduction internal fixation; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PROMs, patient-reported outcome measures; ROBINS-I, Risk of Bias in Non-Randomised Studies of Interventions; ROH, removal of hardware; TMT, tarsometatarsal; yers, years.

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rather than fusion. For bony and fracture-dislocation Lisfranc injuries, ORIF is preferred when joint surfaces are salvageable and arthrodesis when long-term preservation is not feasible. However, the findings of this study underscore the importance of individualized treatment strategies to optimize surgical outcomes and functional recovery.

Level of Evidence: Level V.

KEYWORDS
dislocation, fracture, ligament, Lisfranc, surgical treatment

INTRODUCTION

Lisfranc injuries represent a spectrum of midfoot trauma involving disruption of the tarsometatarsal (TMT) joint complex, ranging from purely ligament sprains to fracture-dislocation patterns, making up 1%–3% of foot injuries seen in athletes [43]. However, these injuries are particularly relevant in the athletic population, where even minor instability can threaten performance and career longevity [7]. The inherent stability of the Lisfranc joint complex is maintained by multiple osseous and ligament structures. Disruption to the TMT joints is often precipitated by axial compression or twisting through a plantarflexed foot, which can result in joint space diastasis and transverse arch instability [13, 30].

Unstable ligament Lisfranc injuries are common among athletes and typically result from low-energy mechanisms, whereas bony injuries and fracture-dislocations are often associated with higher-energy trauma such as falls or contact collisions [31, 54]. Weight-bearing radiographs and computed tomography (CT) scans are routinely used to assess osseous alignment, though the role of magnetic resonance imaging (MRI) for the detection of ligament injury remains controversial [24]. Misdiagnosis or delayed recognition can lead to chronic pain, post-traumatic osteoarthritis and loss of athletic performance [30, 31].

Management depends on injury stability and pattern. Stable injuries without displacement may be treated non-operatively, while surgical fixation is indicated when diastasis, subluxation or sagittal instability is present [50]. ORIF remains the standard approach for both ligament and bony Lisfranc injuries when joint surfaces are salvageable, whereas primary arthrodesis is reserved for cases involving extensive chondral damage, comminution or severe fracture-dislocation [36]. Debate persists regarding the optimal surgical approach: ORIF preserves joint motion but carries a risk of hardware removal and post-operative stiffness, while arthrodesis offers durable stability at the cost of midfoot flexibility [4]. Post-operative recovery and return-to-play outcomes remain highly variable, and the lack of standardized management protocols contributes to inconsistent results among athletes. Despite numerous studies, no consensus exists on the optimal management of elite athletes, whose sport-specific demands may alter treatment priorities.

Therefore, the purpose of this study was to combine a systematic review of the literature with an international expert consensus to establish evidence-based recommendations for the diagnosis, surgical management and post-operative rehabilitation of both unstable ligament and fracture-dislocation Lisfranc injuries in elite athletes. By integrating current evidence with the collective experience of leading orthopaedic foot and ankle surgeons worldwide, this initiative aims to provide standardized guidance to optimize clinical outcomes and facilitate a safe and efficient return to play.

MATERIALS AND METHODS

Systematic review

A systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines on PubMed, EMBASE and The Cochrane Library databases [28]. Included articles were those that evaluated surgical treatment of unstable ligament or fracture-dislocation Lisfranc injuries. Clinical commentaries, expert opinions, abstracts without full-text and articles not written in English were excluded. All articles populated by the study search terms were retrieved from their respective databases and uploaded to Rayyan, a public software program designed to assist with abstract and title screening [38]. Duplicates were removed by hand. Once complete, selected articles underwent further full-text screening. Articles that met the inclusion criteria were selected for analysis.

Assessment of the level of evidence (LOE) and methodological quality

The LOE was evaluated based on the guidelines published by *The Journal of Bone & Joint Surgery* [10]. The Joanna Briggs Institute (JBI) Critical Appraisal

Checklist [34] and the Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) [48] were used to assess the quality of data presented in each study. The JBI Critical Appraisal Checklist categorizes a study's quality as high, medium, or low based on the score assigned. A score higher than 70% is considered high quality, a score between 50% and 70% is considered medium quality and a score of less than 50% is considered low quality. The ROBINS-I evaluates the risk of study bias according to seven domains. A study with a score of 4 is considered to have a low risk of bias, a score of 3 is associated with a moderate risk of bias, a score of 2 has a serious risk of bias, and a score of 1 or 0 is considered to have a critical risk of bias.

Data extraction and evaluation

Two independent reviewers extracted and evaluated the data from each individual study. Data on the characteristics of the surgical procedures were collected. In addition, data regarding patient-reported outcome measurements (PROMs), radiological outcomes, failures, complications and secondary surgical procedures were extracted and evaluated.

Statistical analysis

Descriptive statistics were calculated for all continuous and categorical variables. Continuous variables were reported as weighted mean and estimated standard deviation, and categorical variables were reported as frequencies with corresponding percentages. Statistical analyses were conducted using RStudio software (version 4.2.0).

Consensus working group

Approximately 30 global orthopaedic foot and ankle experts were invited to participate and aid in the development of consensus statements for the surgical treatment of Lisfranc injuries. A minimum of 80% completion rate was maintained during voting. The participants were invited to be founding members of the International Foot and Ankle Sports Consensus. Surgeons from 25 countries and 6 continents were selected based on a point system developed by the American Orthopaedic Foot and Ankle Society to evaluate expert credentials. A minimum total score of 8 points was required for individuals to be eligible for participation. Scores were assigned by three independent physicians based on the following criteria: (1) academic position, (2) number of academic publications, (3) number of national or international presentations, (4) professional sports team coverage, and (6) leadership in a professional foot and ankle or sports medicine society (Table 1).

Expert selection was organized such that a minimum of six continents had representation. Continents with a larger proportion of research output and professional sport involvement were allotted additional positions. Once the expert panel was created, experts were invited to recommend additional individuals for evaluation during a second round of screening based on the aforementioned criteria.

Consensus survey

Questions were generated by an initial survey and sent to the expert panel. The Delphi method was used to generate consensus statements, and experts completed four rounds of electronic questionnaires. Participant identities

TABLE 1 Point system used for selection of the expert panel.

Criteria evaluated	Points awarded
Academic position	• Assistant professor: 1 point • Associate professor: 2 points • Full professor: 3 points
Number of academic publications	• 1–10 publications: 1 point • 11–20 publications: 2 points • 21 or more publications: 3 points
Number of national/international presentations and lectures	• 1–5 presentations/lectures: 1 point • 6–10 presentations/lectures: 2 points • 11 or more presentations/lectures: 3 points
Professional sports team coverage	• No coverage: 0 points • Local/regional coverage: 1 point • National/international coverage: 2 points
Leadership role in professional foot and ankle/sports medicine society	• No leadership role: 0 points • Member: 1 point • Officer/board member: 2 points

were recorded alongside their responses. Questions with significant response variation were chosen for a live debate, and example cases with associated imaging were presented. These involved unstable ligament Lisfranc injuries (Figures 1 and 2) and fracture-dislocation Lisfranc injuries (Figures 3 and 4).

Consensus criteria

For each survey question, the degree of agreement was expressed as a percentage rounded to the nearest whole number. Consensus was defined as 75%–85%, strong consensus as 86%–99%, and unanimous consensus was indicated by 100%.

RESULTS

Overall consensus

A total of 16 questions addressing the operative management of unstable ligamentous and bony Lisfranc injuries in athletes were developed from surveys and voting. Of these, 12 statements achieved unanimous

FIGURE 1 AP and lateral weight-bearing radiographs of the right foot and axial MRI of the right foot demonstrating minor Lisfranc instability. AP, anterior–posterior; MRI, magnetic resonance imaging.

FIGURE 2 AP, oblique and lateral radiographs of the left foot and axial and coronal MRI of the left foot demonstrating an unstable ligament Lisfranc injury. AP, anterior–posterior; MRI, magnetic resonance imaging.

FIGURE 3 AP, oblique and lateral radiographs of the left foot and coronal CT of the left and right foot demonstrating Lisfranc fracture and widening. AP, anterior–posterior; CT, computed tomography.

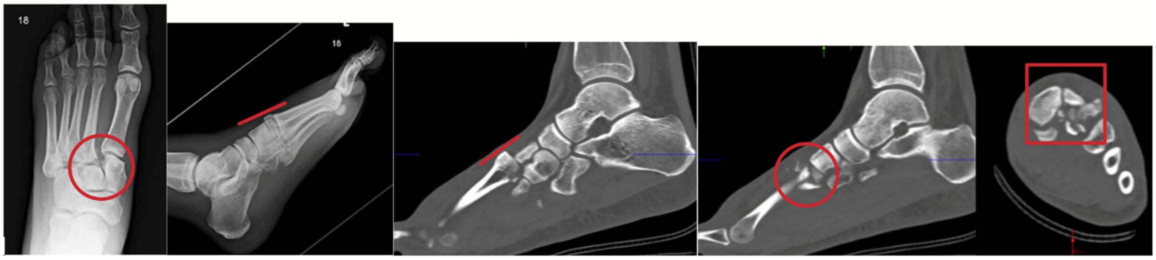

FIGURE 4 AP and lateral radiographs of the left foot and axial and coronal CT of the left foot demonstrating Lisfranc fracture with a subluxation/dislocation injury. AP, anterior–posterior; CT, computed tomography.

consensus, and 4 achieved strong consensus. The final consensus statements are presented below.

Consensus statements

I. Indications and Diagnosis

Q1: What are the indications for surgical intervention?

A1: 100% Unanimous: Evidence of sagittal or coronal instability, subluxation, dislocation, diastasis, any displacement or malalignment.

Q2: What additional scans may be utilized in the diagnosis of minor/moderate Lisfranc instability?

A2: Strong Consensus: Weight-bearing bilateral CT scan and MRI.

II. Operative Management

Q3: Do you fix or fuse ligament Lisfranc injuries with instability in athletes?

A3: 100% Unanimous: Open reduction and internal fixation is preferred in elite athletes with unstable ligament Lisfranc injuries.

Q4: What fixation construct do you most often utilize for unstable ligament Lisfranc injuries with instability?

A4: 100% Unanimous: Multiple methods for open reduction and internal fixation are viable treatment options for unstable ligament Lisfranc injuries.

Q5: Do you fix or fuse fracture/dislocation Lisfranc injuries in athletes?

A5: 100% Unanimous: If more than 50% of the articular cartilage is found to be damaged during intraoperative assessment, arthrodesis may be considered. This is particularly important when managing the second TMT joint. However, first TMT arthrodesis may alter midfoot biomechanics; therefore, these potential limitations and their implications for return to sport should be carefully discussed.

Q6: When do you utilize percutaneous fixation?

A6: 100% unanimous: Percutaneous fixation of Lisfranc injuries is a viable option if an intraoperative stress examination of the joints assures that the anatomic reduction and fixation are stable.

Q7: What instrumentation do you typically utilize for reduction?

A7: 100% Unanimous: Pointed reduction forceps/clamps and fluoroscopy with (mini) C-arm.

Q8: What intraoperative criteria do you utilize to determine adequate reduction/fixation?

A8: Strong Consensus: Direct visualization of the joint, intraoperative fluoroscopic imaging, stability post fixation with fluoroscopic stress views.

Q9: What are poor prognostic indicators found intraoperatively?

A9: 100% Unanimous: Comminution, intra-articular fractures, chondral injury, malalignment or malreduction, improperly positioned hardware and the number of joints involved.

III. Perioperative considerations

Q10: What anaesthesia do you prefer?

A10: 100% Unanimous: The use of distal blocks/local anaesthesia at the level of the ankle, foot or incision is supported.

Q11: Do you use deep vein thrombosis (DVT) prophylaxis following surgical fixation?

A11: 100% Unanimous: DVT prophylaxis is recommended while the athlete is in the non-weight-bearing phase following surgical stabilization.

IV. Post-operative Management and Return to Sport

Q12: When using Lisfranc screws or fixing with plates, do you remove hardware?

A12: 100% Unanimous: If ORIF is performed, hardware may be removed between 3 and 5 months postoperatively based on the surgeon's preference. Hardware may also be maintained. If maintained, it is important to have a discussion in advance that the hardware may break and that it can be removed if symptomatic.

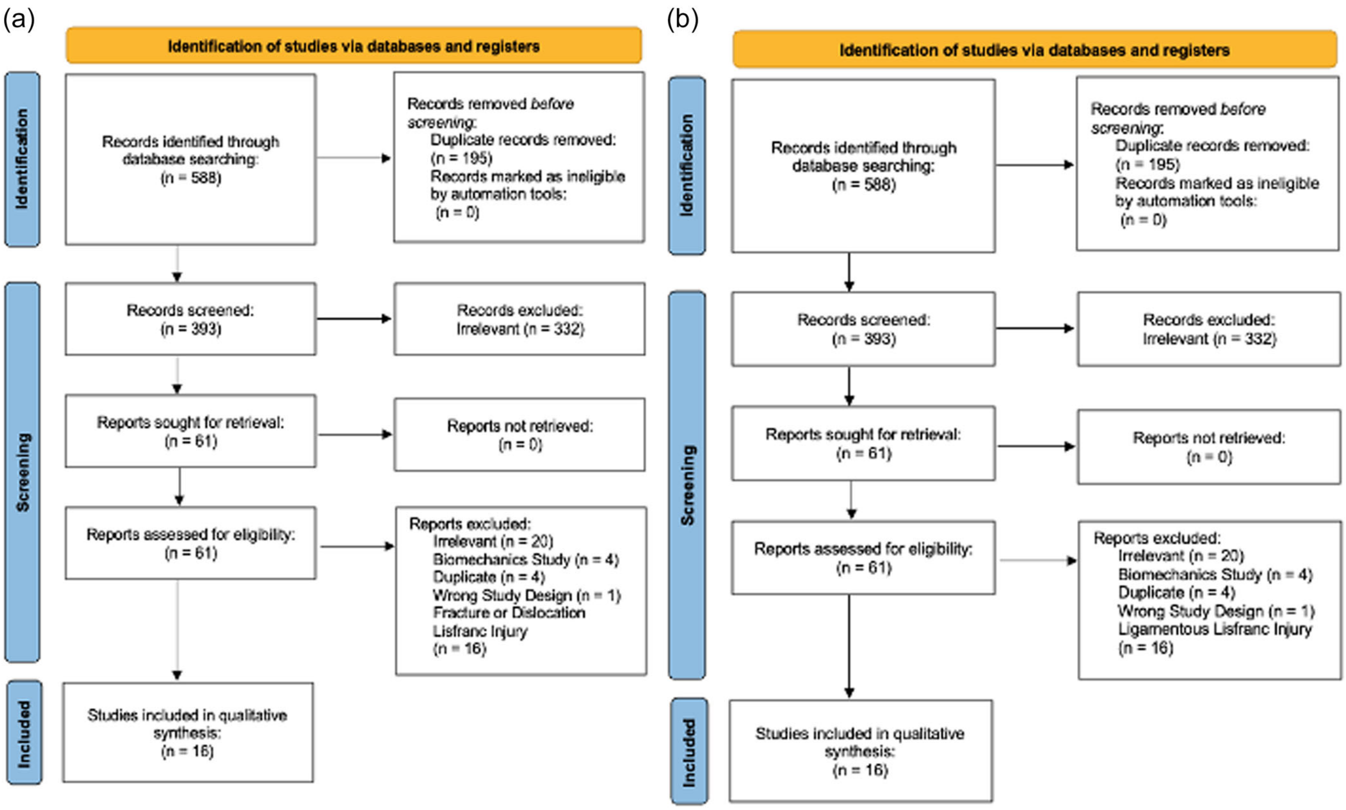

FIGURE 5 PRISMA for systematic review of (a) unstable ligament Lisfranc injuries and (b) Lisfranc bony injuries. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Q13: When can an athlete return to sport following the removal of hardware?

A13: 100% Unanimous: Following removal of hardware in Lisfranc variants, athletes should expect to return to practice or play after 2–6 weeks.

Q14: Does the type of sport played by the athlete influence the method of fixation?

A14: 100% Unanimous: Type of sport may influence the method of fixation when performing ORIF or arthrodesis. In addition, athletes involved in sports requiring more flexibility may benefit from ORIF rather than arthrodesis.

V. Adjuncts and Complications

Q15: Is there an indication for the use of orthobiologics in the management of unstable ligament Lisfranc injuries? If yes, which orthobiologic?

A15: Strong Consensus: No.

Other: 5% platelet-rich plasma, 9% concentrated bone marrow aspirate, 9% iliac crest bone graft and 5% platelet-derived growth factor.

Q16: What are common complications following these injuries?

A16: Strong Consensus: Deep peroneal nerve injury, superficial wound infection, post-traumatic osteoarthritis, midfoot stiffness, hardware failure and persistent pain.

Systematic review: Study characteristics

A total of 16 studies comprising 409 patients met the inclusion criteria. Two injury subgroups were evaluated: (1) unstable ligament Lisfranc injuries (249 patients across 16 studies) and (2) bony Lisfranc injuries (157 patients across 16 studies). The full literature search and screening process are demonstrated in Figure 5a,b.

Within the unstable ligament Lisfranc group, two fixation categories and their patient cohorts were evaluated: suture button fixation (SBF) (46 patients) and open reduction internal fixation (ORIF) (203 patients). The weighted mean follow-up period was 21.7 months (range: 7.3–42) in the SBF group and 53.5 months (range: 13–99.6) in the ORIF group. The average age among study participants was 28.6 years in the SBF group and 27.9 years in the ORIF group. The top three sports played in the SBF group were soccer (28.6%), dance (25.0%) and rugby (14.3%). In

TABLE 2 Study the characteristics and demographics of ligament Lisfranc injuries.

Author	LOE	*N* patients	*N* feet	Follow-up (mo)	Age (y)	M/F	Sports	Level of play	Military activity	Diastasis	Myerson classification	Nunley classification
Suture button fixation												
Charlton et al. [6]	4	7	7	25	24.6	1M/6F	Dance = 5 Soccer = 2	Professional = 5, NCAA Division 1 = 2	0	n/r	n/r	n/r
Jain et al. [22]	4	5	5	24	22.1	5M/0F	Professional soccer Rugby players	Professional=5	0	n/r	n/r	n/r
Hoskins et al. [21]	4	15	15	7.3	35.2	8M/7F	7 'athletes', sport not stated	n/r	0	n/r	n/r	n/r
Sullivan et al. [49]	4	12	12	42	21.1	9M/3F	NRL = 6, NRL Referee = 1, WNRL = 1, Wakeboarding = 1, Gymnast = 1, Dancer = 2	Professional = 12	0	n/r	n/r	n/r
Gee et al. [14]	3	6	6	13.3	29.7	5M/1F	Football = 3, Softball = 1, Kickball = 1, Basketball = 1	n/r	6	4.1	n/r	Stage II = 6
Cottom et al. [11]	5	1	1	10	39	0M/1F	n/r	n/r	n/r	n/r	n/r	n/r
Open reduction internal fixation												
Porter et al. [40]	4	82	82	n/r	21	64M/18F	Football = 48, basketball = 12, wakeboarding = 5, track = 3, rugby = 3, lacrosse = 3, gymnastics = 2, cheer = 2, wrestling = 2, soccer = 2, softball = 2, motorbike = 1	Professional and collegiate, numbers not provided	0	n/r	n/r	Stage II = 82
Saxena et al. [44]	4	12	12	Cannot extract	26.3	5M/7F	Soccer = 4, Gymnastics = 1, Basketball = 1, Running;= 1, Multi = 1, Walking = 1, American football = 1, Racquetball = 1, Volleyball = 1	n/r	0	≥3	n/r	n/r
Cassinelli et al. [5]	4	8	8	37.7	39.8	1M/7F	Gymnastics = 1, Softball = 1	Collegiate = 2	0	4.2	n/r	n/r
Gee et al. [14]	3	6	6	13	25.7	5M/1F	n/r	n/r	6	4.2	n/r	Stage II = 6
Nunley et al. [35]	4	2	2	n/r	20	1M/1F	Football = 1 Soccer = 1	n/r	0	3.5	B1 = 1 B2 = 1	Stage II = 2
Shapiro et al. [47]	4	1	1	41	21.2	0M/1F	Gymnastics = 1	n/r	0	5	n/r	n/r

(Continues)

TABLE 2 (Continued)

Author	LOE	N patients	N feet	Follow-up (mo)	Age (y)	M/F	Sports	Level of play	Military activity	Diastasis	Myerson classification	Nunley classification
Vopat et al. [51]	4	10	10	36.5	25.4	n/r	Soccer = 2, Football = 3, Cross-training = 2, Softball = 1, Baseball = 2	Professional = 1, College = 1, High school = 3, Recreational = 5,	0	3.6	n/r	Stage II = 7, Stage III = 2, n/a = 1
Osbahr et al. [37]	4	3	3	n/r	n/r	n/r	American football=3	Professional=3	n/r	n/r	n/r	n/r
Abbasian et al. [1]	3	29	29	99.6	39.9	19M/10F	n/r	n/r	0	n/r	n/r	n/r
Wagner et al. [53]	4	18	18	32.6	35.7	9M/9F	n/r	n/r	n/r	>2	n/r	n/r
Hong et al. [20]	4	32	32	40.6	23.9	29M/3F	Professional Rugby = 17 Professional Soccer = 15	Professional = 32	0	n/r	n/r	Stage II = 32

Abbreviations: D1, division 1; LOE, level of evidence; M/F, male/female; mo, months; MVC, motor vehicle collision; N, number; NCAA, National Collegiate Athletics Association; n/r, not recorded; NRL, National Rugby League; ORIF, open reduction internal fixation; WNRL, women's National Rugby League; y, years.

the ORIF group, the top three sports played were football (38.1%), soccer (16.3%) and rugby (11.6%). Overall, 91.7% of SBF patients were professional athletes, while the remaining 8.3% were collegiate athletes. In the ORIF group, 77.0% of patients were professional athletes, 6.4% were collegiate athletes and 10.6% were recreational athletes. Study characteristics are demonstrated in Table 2 and the risk of bias assessment is presented in Table 3.

Among patients with fracture-dislocation Lisfranc injuries, three surgical interventions were reported: ORIF (123 patients), arthrodesis (31 patients) and SBF (3 patients). The mean follow-up period was 59.5 months (range: 9–109.2) for ORIF, 50.9 months (range: 46.2–52) for arthrodesis and 9.5 months (range: 9.5) for SBF. The mean age was 29.2 years in the ORIF group, 44.3 years in the arthrodesis group, and 18.3 years in the SBF group. In the ORIF group, the top three sports were running (71.9%), football (7.9%) and gymnastics (5.0%). All patients undergoing arthrodesis were runners. Of the three SBF patients, one played basketball, one was a cheerleader and one did not report the sport. In the ORIF group, 45.0% were professional athletes, 5.0% were semi-professional, 20.0% were collegiate, 25.0% were high school and 5.0% were recreational athletes. Level of play was unreported for arthrodesis patients, and only one SBF patient (high school) reported competition level. Study characteristics are demonstrated in Table 7 and the risk of bias assessment is presented in Tables 3–6.

Systematic review: Surgical technique and post-operative foot and ankle function

Among patients with unstable ligament Lisfranc injuries, surgical constructs used in the SBF group included the Mini TightRope® (Arthrex) in 30 patients (65.2%), the *Internal*Brace™ (Arthrex) in 15 patients (32.6%) and the Endobutton™ (Smith and Nephew) in 1 patient (2.2%). Surgical constructs utilized to achieve ORIF included screws alone (136, 67.3%), plates alone (37, 18.2%), screws and plates (29, 14.3%) and ORIF with Endobutton™ (Smith and Nephew) (1, 0.5%). Additional use of percutaneous Kirschner wires was reported in 10 patients (4.9%) due to failure of the lateral rays to reduce after the initial reduction. Foot and ankle function following surgery was evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) score. The mean post-operative AOFAS score was 95.5 in the SBF group and 89.4 in the ORIF group.

Among patients with fracture-dislocation Lisfranc injuries, surgical constructs reported for ORIF included screws alone (43.4%, 23 patients), plates and screws (56.6%, 30 patients); the remaining cases did not specify construct details. No hardware details were reported for the arthrodesis group. All reported SBF

TABLE 3 Evaluation of study bias using JBI Critical Appraisal Checklist: Case series for minor and moderate ligament Lisfranc injuries.

Case Series	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Jain et al. [22]	N	U	U	Y	Y	U	N	Y	N	N
Hoskins et al. [21]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N/A
Sullivan et al. [49]	Y	Y	Y	N	N	Y	Y	Y	Y	N/A
Gee et al. [14]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nunley et al. [35]	N	Y	Y	N	N	Y	Y	Y	N	N/A
Charlton et al. [6]	Y	Y	Y	N	N	Y	Y	U	U	N/A
Cassinelli et al. [5]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Wagner et al. [53]	Y	Y	Y	Y	N	Y	Y	Y	N	N
Osbahr et al. [37]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Shapiro et al. [47]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N/A
Vopat et al. [51]	Y	Y	Y	Y	N	Y	Y	Y	U	N
Porter et al. [40]	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Saxena et al. [44]	Y	Y	Y	N	N	Y	Y	Y	Y	Y
Saxena et al. [45]	Y	Y	Y	N	U	Y	Y	Y	Y	N/A
Miyamoto et al. [33]	Y	Y	Y	U	Y	Y	Y	Y	U	Y
Hong et al. [20]	Y	Y	Y	U	Y	Y	Y	Y	Y	Y
Lim et al. [29]	Y	Y	Y	U	U	Y	Y	Y	Y	N/A
Gunio et al. [17]	Y	Y	Y	N/A	N/A	Y	Y	Y	Y	N/A
Meyer et al. [32]	Y	Y	Y	U	Y	Y	Y	Y	Y	Y

Note: Domains assessed the following: D1: Were there clear criteria for inclusion in the case series? D2: Was the condition measured in a standard, reliable way for all participants included in the case series? D3: Were valid methods used for the identification of the condition for all participants included in the case series? D4: Did the case series have consecutive inclusion of participants? D5: Did the case series have complete inclusion of participants? D6: Was there clear reporting of the demographics of the participants in the study? D7: Was there clear reporting of clinical information of the participants? D8: Were the outcomes or follow-up results of cases clearly reported? D9: Was there clear reporting of the presenting site(s)/clinic(s) demographic information? D10: Was statistical analysis appropriate? All domains answered yes, no, unclear, or not applicable. The article received an overall appraisal.

TABLE 4 Evaluation of study bias using JBI Critical Appraisal Checklist: Case report for minor and moderate ligament Lisfranc injuries.

	D1	D2	D3	D4	D5	D6	D7	D8	Overall appraisal
Cottom et al. [11]	N	Y	Y	Y	Y	Y	Y	Y	Include

Note: Domains assessed the following: D1: Were the patient's demographic characteristics clearly described? D2: Was the patient's history clearly described and presented as a timeline? D3: Was the current clinical condition of the patient on presentation clearly described? D4: Were diagnostic tests or methods and the results clearly described? D5: Were the intervention(s) or treatment procedure(s) clearly described? D6: Was the post-intervention clinical condition clearly described? D7: Were adverse events (harms) or unanticipated events identified and described? D8: Does the case report provide takeaway lessons? All domains answered yes, no, unclear, or not applicable. The article received an overall appraisal.

TABLE 5 Evaluation of study bias using the Risk of Bias in Non-Randomized Studies of Interventions for minor and moderate ligament Lisfranc injuries.

	D1	D2	D3	D4	D5	D6	D7	Overall
Abbasian et al. [1]	Moderate risk	Moderate risk	Low risk	Low risk	Low risk	Low risk	Low risk	Moderate risk

Note: Domains assessed the following: D1: Bias due to confounding, D2: Bias in selection of study participants, D3: Bias in classification of interventions, D4: Bias due to deviation from intended interventions, D5: Bias due to missing data, D6: Bias in measurement of outcomes, and D7: Bias in selection of reported results.

constructs (2 of 2 studies, 100%) utilized the Arthrex Mini TightRope endobutton system. Post-operative AOFAS scores demonstrated weighted mean values of 86.1 for the ORIF group and 81.0 for the arthrodesis group (SBF not reported).

Systematic review: Complications, failure rate and secondary surgical procedures

Treatment failure was defined as persistent post-operative symptoms or the need for a secondary surgical procedure other than hardware removal. Among patients in the ligament Lisfranc injury group, the failure rate was 0% (0/46) in the SBF group and 4.9% (10/203) in the ORIF group. Complications occurred in 10.9% of SBF patients (5/46) and 18.2% of ORIF patients (37/203). Reported complications in the SBF group included transient deep peroneal nerve neuropraxia (1, 2.2%), medial bursitis near the interference screw (1, 2.2%), sensory changes (1, 2.2%), irritation from the medial button (1, 2.2%) and paresthesia on the dorsum of the foot (1, 2.2%). The most common complication in the ORIF group was midfoot arthritis (12, 5.9%), followed by persistent pain (8, 3.9%), loss of reduction (4, 1.9%), deep peroneal nerve neuropraxia (5, 2.5%), broken screw (4, 2.0%), infection (1, 0.5%) and DVT (1, 0.5%). Secondary surgical procedures were necessary in 30.5% (62/203) ORIF patients, most commonly hardware removal (58, 93.5%). Other secondary surgical procedures reported among ORIF were Lapidus (1, 1.6%) and Lisfranc arthrodesis (1, 1.6%). No secondary surgical procedures were performed in the SBF group (0 out of 46). Table 8 further depicts these results.

Among patients with fracture-dislocation Lisfranc injuries, the failure rate after ORIF was 13.8% (17/123), with an overall complication rate of 30.1% (38/123). The most common complication was midfoot arthritis (16.3%, 20/123). Secondary surgical procedures occurred in 90.2% of ORIF patients (110/123), primarily hardware removal (89.4%). For arthrodesis, the failure rate was 12.9% (4/31), and the complication rate was 35.5% (11/31). The most common complication was nonunion (16.1%, 5). Other complications included adjacent degenerative joint changes (9.7%, 4), broken or symptomatic hardware (6.5%, 2) and superficial wound infection (3.2%, 1). Secondary surgical procedures occurred in 22.6% patients (7/31), most often hardware removal (12.9%, 4). Within the SBF group, the failure rate was 0% (0/2), while the complication rate was 50.0% (1/2). Reported complications included symptomatic hardware (50.0%) and tenosynovitis (50.0%). One of two patients underwent a secondary surgical procedure (hardware removal). Table 9 further illustrates these results.

TABLE 6 Evaluation of study bias using MINORS criteria for bony Lisfranc injury papers.

Author	Total bias score	Total possible bias score 16 for non-comparative studies 24 for comparative studies
Open reduction internal fixation		
Koehler et al. [25][a]	13	16
Patillo et al. [39]	8	16
Chilvers et al. [8]	8	16
Haddix et al. [18]	5	16
Curtis et al. [12]	12	16
Hirano et al. [19]	10	16
Bleazey et al. [2]	13	16
Abbasian et al. [1]	20	24
Wagner et al. [53]	13	16
Lim et al. [29][a]	10	16
Gillespie et al. [15]	6	16
Diebal et al. [13]	7	16
Arthrodesis		
Koehler et al. [25][a]	13	16
Reinhardt et al. [41]	21	24
Suture button fixation		
Cottom et al. [11]	9	16
Rella et al. [42]	9	16
Non-operative treatment		
Lim et al. [29][a]	10	16
Wadsworth et al. [52]	10	16
Kriz et al. [26]	9	16

Note: Studies categorized into comparative or non-comparative groups, with the comparative studies graded from 0 to 24 points and the non-comparative groups graded from 0 to 16 points, with each item worth 0–2 points.

Abbreviation: MINORS, Methodological Index for Non-Randomized Studies.

[a]Study included patients in multiple treatment groups, so it appears twice in the table.

DISCUSSION

The most important finding of this study is that ORIF remains the most utilized and evidence-supported treatment for unstable ligament Lisfranc injuries in elite athletes, a conclusion unanimously reaffirmed by the international consensus panel. Across the included studies, ORIF achieved reliable anatomic reduction and restoration of midfoot stability, although it was associated with a higher incidence of secondary surgical procedures, most commonly hardware removal. SBF was reported in a smaller subset of ligament Lisfranc injuries and demonstrated comparable short-term functional outcomes with fewer hardware-related complications and no secondary procedures, but with shorter follow-up. In fracture-dislocation Lisfranc injury patients, both ORIF and arthrodesis achieved high rates of return to sport, with similar complication and failure rates, although ORIF demonstrated a higher incidence of secondary procedures, primarily for hardware removal. When these findings are paired and

TABLE 7 Study characteristics and demographics of bony Lisfranc injuries.

Author	LOE	N patients	N feet	Follow-up (mo)	Age (y)	M/F	Sports	Level of play	Military activity	Diastasis	Myerson classification	Nunley classification
Open reduction internal fixation												
Koehler et al. [25]	4	64	64	41.5	28	N/E	Running N = 64	N/R	64	N/R	N/R	N/R
Patillo et al. [39]	4	1	1	10	29	1/0	Hockey N = 1	Professional N = 1	N/R	N/R	N/R	N/R
Chilvers et al. [8]	4	5	5	N/R	18.4	0/5	Gymnastics N = 5	Elite N = 5	N/R	N/R	C1 N = 1	N/R
Haddix et al. [18]	4	1	1	N/R	26	0/1	Soccer N = 1	Recreational N = 1	N/R	N/R	N/R	N/R
Curtis et al. [12]	4	2	2	30.5	25.5	2/0	Windsurfing N = 1 Basketball N = 1	N/R	N/R	N/R	B2 N = 2	N/R
Hirano et al. [19]	4	1	1	12	15	1/0	N/R	N/R	0	N/R	B2 N = 1	N/R
Bleazy et al. [2]	4	13	13	N/R	21.9	12/1	Football N = 7 Baseball N = 2 Boxing N = 1 Motocross N = 1 Snowboarding N = 1 Volleyball N = 1	Professional N = 2 Semi-Professional N = 1 College N = 4 High School N = 4	0	N/R	B2 N = 13	N/R
Aabbasian et al. [1]	3	29	29	109.2	38	19/10	N/R	N/R	0	N/R	N/R	N/R
Wagner et al. [53]	4	4	4	37.3	34.8	3/1	N/E	N/R	N/R	>2 mm indication, no average N/R	N/R	N/R
Lim et al. [29]	4	1	1	N/R	29	0/1	Soccer N = 1	Professional N = 1	0	N/R	N/R	N/R
Gillespie et al. [15]	4	1	1	9	16	0/1	Dance N = 1	N/R	0	N/R	N/R	N/R
Diebal et al. [13]	5	1	1	N/R	18	1/0	Lacrosse N = 1	College N = 1	N/R	N/R	N/R	N/R
Arthrodesis												

(Continues)

TABLE 7 (Continued)

Author	LOE	N patients	N feet	Follow-up (mo)	Age (y)	M/F	Sports	Level of play	Military activity	Diastasis	Myerson classification	Nunley classification
Koehler et al. [25]	4	6	6	46.2	29	N/E	Running *N* = 6	N/R	6	N/R	N/R	N/R
Reinhardt et al. [41]	3	25	25	52	48	8/17	N/R	N/R	0	N/R	N/R	N/R
Suture button fixation												
Cottom et al. [11]	4	2	2	9.5	20	2/0	Basketball *N* = 1 N/R *N* = 1	High School (soon NCAA Division 1) *N* = 1 N/R = 1	N/R	N/R	N/R	N/R
Rella et al. [42]	5	1	2	N/R	15	0/1	Cheerleading *N* = 1	N/R	N/R	N/R	N/R	N/R

reaffirmed by the international consensus, arthrodesis appears more advantageous in cases of extensive chondral damage or comminution, particularly when long-term joint preservation is not feasible. Overall, the combined results of the systematic review and expert consensus underscore the importance of individualized operative management based on injury pattern, cartilage integrity and sport-specific demands, with the shared goal of minimizing morbidity and ensuring a safe and optimized return to play.

The findings observed in the unstable ligament Lisfranc injury group align with prior literature and were reaffirmed by the international consensus, which emphasized that fixation should be favoured over fusion for these injuries in athletes. ORIF has historically been preferred because it provides direct visualization and stable reduction; however, its rigidity may limit midfoot motion and contribute to post-operative stiffness or arthrosis in high-demand athletes [6, 27]. Flexible fixation systems, including suture-button constructs, have been introduced to balance stability with physiologic motion, particularly in sports that rely on dynamic midfoot flexibility such as dancers [6]. Emerging evidence suggests that suture button constructs may reduce post-operative complications, accelerate rehabilitation and shorten return-to-play times compared with intra-articular screw fixation [49, 55]. Although these early results are promising, current studies are limited by small sample sizes and shorter follow-up. In this study, the average follow-up duration in the ORIF group was more than twice that of the SBF group, which may influence reported complication rates. Further high-quality, longitudinal studies are needed to determine whether the short-term benefits of SBF translate into durable outcomes comparable to ORIF.

ORIF and arthrodesis represent the two most common treatment modalities for Lisfranc fractures and fracture-dislocation injuries, particularly within the athletic population [3, 4]. Despite their widespread use, the current literature provides limited guidance on when each approach should be preferred. Many studies fail to clearly report the rationale behind the decision to fix or fuse, and those that do address this question offer inconsistent criteria and outcomes [25, 39]. The present findings, supported by the international consensus, help clarify treatment management. ORIF remains the preferred option when articular surfaces are salvageable, offering the potential to preserve motion and maintain midfoot kinematics, whereas arthrodesis is typically indicated when more than 50% of the articular cartilage is disrupted or in cases of comminution. Similar to the consensus statements, most athletes with bony fracture or fracture-dislocation injuries in this review were treated with ORIF compared to arthrodesis. The consensus group also emphasized that sport type influences surgical decision-making: athletes involved in sports requiring greater midfoot flexibility

TABLE 8 Post-operative ligament Lisfranc outcomes in suture button fixation versus open reduction internal fixation (ORIF).

	Suture button fixation	ORIF
Number of patients	46	203
Weighted mean follow-up (mo)	21.7 ± 13.8	53.5 ± 29.4
Top 3 sports (*N*, %)	Soccer = 8 (28.6%), Dancing = 7 (25.0%), WNRL = 4 (14.3%)	Football = 56 (38.1%), Soccer = 24 (16.3%), Rugby = 17 (11.6%)
Level of play	Professional = 22 (91.7%), college = 2 (8.3%)	Professional = 36 (77.0%), Collegiate = 3 (6.4%), High school = 3 (6.4%), Recreational = 5 (10.6%)
Weighted time to full weight-bearing (weeks)	7.0 ± 2.2	8.6 ± 2.9
Complication rate	5 (10.9%)	37 (18.2%)
Failure rate	0 (0%)	10 (4.9%)
Secondary surgical procedures	0 (0%)	62 (30.5%)

Note: All results were pooled to yield a sample-weighted mean.

TABLE 9 Pooled data for bony Lisfranc injuries.

	Open reduction internal fixation	Arthrodesis	Suture button fixation
N, Number of patients per treatment type	123	31	3
Weighted mean follow-up, months	59.5	50.9	9.5
Top 3 sports, *N* (%)	Running: 64 (71.9%) Football: 7 (7.9%) Gymnastics: 5 (5.6%)	Running: 6 (100%)	Basketball: 1 (50.0%) Cheerleading: 1 (50.0%)
Level of play, *N* (%)	Professional: 9 (45.0%) Semi-professional: 1 (5.0%) Recreational: 1 (5.0%) College: 4 (20.0%) High school: 5 (25.0%)	*Not recorded*	High school: 1 (100.0%) *Not recorded*
Weighted mean time from injury to surgery, Days	32.7	*Not recorded*	*Not recorded*
Weighted mean time to full weight bearing, Weeks	10.8	8.0	*Not recorded*
Complications, *N* (%)	38 (30.8%)	11 (35.5%)	2 (100%)
Failures, *N* (%)	17 (13.8%)	4 (12.9%)	0 (0%)
Secondary surgical procedures, *N* (%)	110 (90.2%)	7 (22.6%)	1 (50.0%)

are more likely to benefit from ORIF, while arthrodesis may be favoured when stability and long-term durability are prioritized. Type of athletic activity varied and was not specific to individual sports in the ORIF and arthrodesis groups in the literature. Although suture-button fixation has rarely been reported for bony Lisfranc injuries, its selective use in a small number of athletes highlights an emerging interest in motion-preserving constructs for specific high-demand cases [11, 42].

In patients with unstable ligament Lisfranc injuries, strategies for SBF include the use of a Mini TightRope® (Arthrex) or *Internal*Brace™ (Arthrex). The tightrope construct allows for biomechanical stability while preserving pre-injury articulation between the medial cuneiform and second metatarsal, thereby reducing the risk of post-traumatic osteoarthritis and persistent joint stiffness [57]. The internal brace protects against bone and cartilage loss by promoting collagen ingrowth [9]. Moreover, avoiding placement of a medial cuneiform button can reduce the risk of tibialis anterior tendon irritation [21], and using a K-wire instead of a drill bit minimizes articular damage during implantation [56]. Fixation constructs commonly used in ORIF techniques include transarticular screws, dorsal bridge plating, or a combination of both screws and plates. Dorsal plates provide rigid fixation without interrupting the articular surfaces of the TMT joint, but perfect anatomical reduction can be difficult to achieve using plates alone. Potential complications following ORIF include cartilage injury, screw loosening, head fracture and hardware breakage [56]. However, Hong et al. utilized extra-articular dorsal bridge plating with routine retention of hardware, demonstrating that this approach can enable elite athletes to return to sport without significant mechanical complications [20]. Selective hardware removal occurred in 4 out of 32 patients [20].

For bony Lisfranc fractures and fracture-dislocation injuries, fixation constructs are designed to restore column alignment and maintain anatomic reduction across multiple TMT joints [46]. Reported constructs in the literature, consistent with the consensus findings, include dorsal bridge plating, isolated transarticular screw fixation and combined plate-and-screw configurations. Bridge plating, particularly when combined with a Lisfranc screw, was the most frequently reported construct among consensus participants. Dorsal bridge plates provide rigid fixation without violating the articular surface, while transarticular screws offer additional stability in cases of comminution or displacement [1, 2, 13, 23, 25, 53]. Many surgeons employ a hybrid approach to optimize fixation strength and facilitate earlier mobilization. Both the consensus panel and literature emphasized that implant selection should be individualized based on patient anatomy, sport-specific demands and injury characteristics.

In the unstable ligament Lisfranc injury group, the most common complication following SBF is discomfort at the button insertion site and knot irritation. Additional complications that have been reported include loss of reduction resulting in late diastasis, suture abscess, extensor hallucis longus tendinopathy and subsidence [11, 18]. However, reports of suture button subsidence to date have been limited to older patients with poor bone quality [3]. Interestingly, Sullivan et al. [49] found that a knotless suture button can be used to reduce the risk of knot irritation and suture abscess. Rates of hardware removal in the literature are as high as 46% for ORIF and 18.4% for arthrodesis; this is in contrast to 0% following SBF [27]. In this study, 30.5% of patients in the ORIF group underwent a secondary surgical procedure, compared to 0% of patients in the SBF group. The indication for reoperation in 58 out of 62 patients in the ORIF group was hardware removal (93.5%). SBF may be particularly advantageous for athletes who wish to avoid the possibility of hardware breakage and future removal.

Among patients with bony Lisfranc injuries, complications commonly include hardware fatigue, midfoot stiffness and arthritis, persistent pain, nerve injury and infection, consistent with both prior literature and consensus statements [1, 13, 25, 41, 42]. This study demonstrated that midfoot stiffness and arthritis were the most common complications following ORIF, whereas nonunion was most frequently observed following arthrodesis. As such, primary arthrodesis may be preferred when minimizing post-operative stiffness and arthrosis is a priority [18]. The consensus statements identified hardware removal as the most frequent secondary procedure following ORIF. This study showed that patients treated with ORIF had a secondary surgical procedure rate of 89.4% (82% ROH, 8.1% secondary fusion). In contrast, 22.6% of arthrodesis patients underwent a secondary procedure, with 9.7% requiring revision and 4 patients (12.9%) undergoing removal of hardware due to hardware failure, symptomatic hardware or patient preference [41]. Consequently, those athletes seeking to avoid future procedures may represent better candidates for arthrodesis. Ultimately, use of sport-specific rehabilitation was also highlighted as an important component of treatment for athletes returning after injury.

Interestingly, a strong consensus was reached against the use of orthobiologics reflecting a cautious stance among experts with respect to the efficacy of these medications in the management of Lisfranc injuries. This contrasts with trends in other orthopaedic areas where the use of biologics has enhanced healing outcomes with minimal potential side effects. At present, there is no current literature on the use of biologics in the conservative treatment of Lisfranc injuries or with midfoot arthrodesis. However, prior studies have found that the use of orthobiologics following arthrodesis largely remains at the discretion of the surgeon, with most physicians reporting use only in patients at high risk for nonunion [16]. Nonetheless, future studies are needed to evaluate the efficacy of these drugs in Lisfranc injuries.

This study was not without limitations. Consensus statements represent expert opinion and are therefore level V evidence. Although the results of the systematic review functioned to bolster or undermine each statement, some statements developed during this consensus could not be substantiated due to a lack of clinical data in the field. Case reports and small case series were included to maximize the available data given the rarity of Lisfranc injuries in elite athletes, though their inclusion inherently limits the overall LOE and generalizability of findings. Efforts to increase the objectivity of participant selection included the use of standardized criteria to evaluate level of interest, degree of expertise, and academic reputation. While this consensus could not be completely void of bias, this initiative provides clinicians with evidence-based guidelines to aid in their management of a complex pathology.

CONCLUSION

Surgical fixation remains the standard of care for unstable Lisfranc injuries, including both unstable ligament and fracture-dislocation patterns, in elite athletes. For unstable ligament injuries, fixation is preferred over fusion, with open reduction and internal fixation remaining the most established and evidence-supported technique. SBF represents a promising motion-preserving alternative that may reduce hardware-related complications and secondary procedures, although long-term data are limited. For bony Lisfranc fracture or fracture-dislocation injuries, ORIF remains the treatment of choice when articular surfaces are salvageable, while primary arthrodesis is favoured in cases involving extensive chondral damage or comminution where long-term joint preservation is not feasible. Ultimately, treatment selection should be individualized according to injury pattern, cartilage integrity and sport-specific demands to achieve anatomic reduction, minimize morbidity and facilitate a safe return to play.

AUTHOR CONTRIBUTIONS

Arianna L. Gianakos: Conceptualization; methodology; formal analysis; investigation; writing—review and editing; supervision. **Julia M. Balboni**: Methodology; writing—original draft. **Arielle Richey Levine**: Methodology; writing—original draft. **Vanessa Boggiano**: Methodology; writing—review and editing. **IFASC Committee**: Formal analysis; investigation; writing—review and editing. **James Butler**: Formal analysis; investigation. **Scott D. Semelsberger**: Writing—original draft. **Sebastian Krebsbach**: Writing—original draft. **Kassidy Webber**: Writing—original draft. **Brendan Conroy**: Writing—original draft. **M. Diane Essis**: Writing—review and editing.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

No Institutional Review Board or Ethics Committee approval was required due to the retrospective collection of publicly available data. All expert recommendations provided here are intended for interprofessional guidance and should not be interpreted as implying any liability.

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REFERENCES

1. Abbasian MR, Paradies F, Weber M, Krause F. Temporary internal fixation for ligamentous and osseous lisfranc injuries: outcome and technical tip. Foot Ankle Int. 2015;36(8):976–83.
2. Bleazey ST, Brigido SA, Protzman NM. Technique Tip: Percutaneous Fixation of Partial Incongruous Lisfranc Injuries in Athletes. Foot Ankle Spec. 2013;6(3):217–21.
3. Brown CL, James NA, Onyeukwu C, Belayneh R, Boakye L, Hogan MV. Patient-reported outcome measures after surgical management of unstable lisfranc injuries in athletes. Foot Ankle Orthop. 2023;8(1):24730114231160762.
4. Carter TH, Heinz N, Duckworth AD, White TO, Amin AK. Management of lisfranc injuries: a critical analysis review, 2023; JBJS Rev.
5. Cassinelli SJ, Moss LK, Lee DC, Phillips J, Harris TG. Delayed open reduction internal fixation of missed, low-energy lisfranc injuries. Foot Ankle Int. 2016;37(10):1084–90.
6. Charlton T, Boe C, Thordarson DB. Suture button fixation treatment of chronic lisfranc injury in professional dancers and high-level athletes. J Dance Med Sci. 2015;19(4):135–9.
7. Chen J, Sagoo N, Panchbhavi VK. The lisfranc injury: a literature review of anatomy, etiology, evaluation, and management. Foot Ankle Spec. 2021;14(5):458–67.
8. Chilvers M, Donahue M, Nassar L, Ii AM. Foot and ankle injuries in elite female gymnasts. Foot Ankle Int. 2007;28(2):214–8.
9. Chona DV, Park CN, Kim BI, Lau BC. Clinical and biomechanical outcomes of suture button fixation for ligamentous lisfranc injury: a systematic review and meta-analysis. Orthop J Sports Med. 2023;11(8):23259671231186387.
10. Christiano A, Barbera J, Frechette G, Selverian S, Gluck M, London D. New level of evidence guidelines change previously published manuscripts' designation. Arch Bone Jt SurgDOI. 2020.
11. Cottom JM, Hyer CF, Berlet GC. Treatment of lisfranc fracture dislocations with an interosseous suture button technique: a review of 3 cases. J Foot Ankle Surg. 2008;47(3):250–8.
12. Curtis MJ, Myerson M, Szura B. Tarsometatarsal joint injuries in the athlete. Am J Sports Med. 1993;21(4):497–502.
13. Diebal AR, Westrick RB, Alitz C, Gerber JP. Lisfranc injury in a west point cadet. Sports Health Multidiscip Approach. 2013; 5(3):281–5.
14. Gee S, Harris MC, Anderson C, Groth A, Ryan P. Lisfranc open reduction and internal fixation in an athletic population: screw versus suture button fixation. Curr Orthop Pract. 2019;30(4): 323–6.
15. Gillespie P, Robertson A, George B, Nihal A. Acute lisfranc joint disruption in a ballet dancer. Foot Ankle Surg. 2005;11(2): 105–8.
16. Greer N, Yoon P, Majeski B, Wilt TJ. Orthobiologics in foot and ankle arthrodesis: a systematic review. J Foot Ankle Surg. 2021;60(5):1029–37.
17. Gunio DA, Vulcano E, Benitez CL. Dynamic stress mri of midfoot injuries: measurable morphology and laxity of the sprained

lisfranc ligament during mechanical loading: a case report. JBJS Case Connect. 2019;9(3):e0228.
18. Haddix B, Ellis K, Saylor-Pavkovich E. Lisfranc fracture-dislocation in a female soccer athlete. Int J Sports Phys TherDOI. 2012;7(2):219–25.
19. Hirano T, Niki H, Beppu M. Newly developed anatomical and functional ligament reconstruction for the Lisfranc joint fracture dislocations: a case report. Foot Ankle Surg. 2014;20(3): 221–3.
20. Hong CC, Calder J. Routine retention of metalwork after extra-articular dorsal plate fixation of ligamentous lisfranc injuries in elite athletes enables early return to sports. Orthop J Sports Med. 2025;13(4):23259671251328045.
21. Hoskins M, Wise P, Unangst A, Shaheen P, Kreulen C, Aynardi M, et al. Early outcomes of lisfranc injuries treated with arthrex internalbrace: a case series. Indian J Orthop. 2024; 58(3):257–62.
22. Jain K, Drampalos E, Clough TM. Results of suture button fixation with targeting device aid for displaced ligamentous Lisfranc injuries in the elite athlete. The Foot. 2017; 30:43–6.
23. Kirzner N, Zotov P, Goldbloom D, Curry H, Bedi H. Dorsal bridge plating or transarticular screws for Lisfranc fracture dislocations: A retrospective study comparing functional and radiological outcomes. Bone Jt J. 2018;100-B(4):468–74.
24. Kitsukawa K, Hirano T, Niki H, Tachizawa N, Mimura H. The Diagnostic Accuracy of MRI to Evaluate Acute Lisfranc Joint Injuries: Comparison With Direct Operative Observations. Foot Ankle Orthop. 2022;7(1):24730114211069080.
25. Koehler L, Waterman BR, Kusnezov NA, Blair JA, Belmont PJ, Orr JD. Occupational outcomes and return to running after operative management of lisfranc injuries in a high-demand population. Foot Ankle Spec. 2022;15(1):18–26.
26. Kriz P, Rafferty J, Evangelista P, Van Valkenburg S, DiGiovanni C. Stress fracture of the second metatarsal and sprain of lisfranc joint in a pre-professional ballet dancer. J Dance Med Sci. 2015;19(2):80–5.
27. Lachance AD, Giro ME, Edelstein A, Lee W. Suture button fixation yields high levels of patient reported outcomes, return to sport, and stable fixation in isolated Lisfranc injuries: A systematic review. J ISAKOS. 2023;8(6):474–83.
28. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol. 2009;62(10):e1–e34.
29. Lim W, Heysen J, Ilic J, Beamond B, Zadow S. Lisfranc sprain with second metatarsal base adaptive stress response in high-level athletes: case series and novel perspective on a distinct entity of chronic low-energy Lisfranc Injury. In: Mayr J ed. Case Rep Orthop. 2022; 2022. p. 1–6
30. Maduka GC, Maduka DC, Yusuf N. Lisfranc sports injuries: what do we know so far? Cureus. 2023.
31. Mascio A, Greco T, Maccauro G, Perisano C. Lisfranc complex injuries management and treatment: current knowledge. Int J Physiol Pathophysiol Pharmacol. 2022;14(3):161–70.
32. Meyer SA, Callaghan JJ, Albright JP, Crowley ET, Powell JW. Midfoot sprains in collegiate football players. Am J Sports Med. 1994;22(3):392–401.
33. Miyamoto W, Takao M, Innami K, Miki S, Matsushita T. Ligament reconstruction with single bone tunnel technique for chronic symptomatic subtle injury of the Lisfranc joint in athletes. Arch Orthop Trauma Surg. 2015;135(8): 1063–70.
34. Moola S, Munn Z, Sears K, Sfetcu R, Currie M, Lisy K, et al. Conducting systematic reviews of association (etiology): The Joanna Briggs Institute's approach. Int J Evid Based Healthc. 2015;13(3):163–9.
35. Nunley JA, Vertullo CJ. Classification, investigation, and management of midfoot sprains: lisfranc injuries in the athlete. Am J Sports Med. 2002;30(6):871–8.
36. O'Connor KP, Tackett LB, Riehl JT. Primary arthrodesis versus open reduction internal fixation for acute Lisfranc injuries: a systematic review and meta-analysis. Arch Orthop Trauma Surg. 2024;145(1):49.
37. Osbahr DC, O'Loughlin PF, Drakos MC, Barnes RP, Kennedy JG, Warren RF. Midfoot sprains in the national football league. Am J Orthop Belle Mead NJ. 2014;43(12):557–61.
38. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):210.
39. Patillo D, Rudzki J, Johnson J, Matava M, Wright R. Lisfranc injury in a national hockey league player: a case report. Int J Sports Med. 2007;28(11):980–4.
40. Porter DA, Barnes AF, Rund A, Walrod MT. Injury pattern in ligamentous lisfranc injuries in competitive athletes. Foot Ankle Int. 2019;40(2):185–94.
41. Reinhardt KR, Oh LS, Schottel P, Roberts MM, Levine D. Treatment of Lisfranc fracture-dislocations with primary partial arthrodesis. Foot Ankle Int. 2012;33(1):50–6.
42. Rella RT, Yockers RB, Cox T, Mullens J. Cheerleading accident resulting in bilateral lisfranc injuries in a young female athlete: a case report. Foot Ankle Surg Tech Rep Cases. 2023;3(3):100312.
43. Sadasivan P, Cooper L, Currall V. Lisfranc injuries in athletes: a review. Orthop Trauma. 2024;38(1):18–24.
44. Saxena A. Bioabsorbable screws for reduction of Lisfranc's diastasis in athletes. J Foot Ankle Surg. 2005;44(6):445–9.
45. Saxena A, Hofer D. Stabilization of the fourth metatarsal–cuboid lateral lisfranc injury: early results of an innovative technique using suture anchors. J Foot Ankle Surg. 2018; 57(2):409–13.
46. Scolaro J, Ahn J, Mehta S. In brief: Lisfranc fracture dislocations. Clin Orthop. 2011;469(7):2078–80.
47. Shapiro MS, Wascher DC, Finerman GAM. Rupture of Lisfranc's ligament in athletes*. Am J Sports Med. 1994;22(5): 687–91.
48. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016.
49. Sullivan M, Peckston D, Alpuerto B. Shortening the return-to-play times in elite athletes with unstable isolated lisfranc ligament injuries using a knotless interosseous suture button: case series and literature review. Orthop J Sports Med. 2022; 10(6):23259671221102969.
50. Van Den Boom NAC, Stollenwerck GANL, Lodewijks L, Bransen J, Evers SMAA, Poeze M. Lisfranc injuries: fix or fuse?: a systematic review and meta-analysis of current literature presenting outcome after surgical treatment for Lisfranc injuries. Bone Jt Open. 2021;2(10):842–9.
51. Vopat BG, Vopat ML, Van Dijk PAD, Hazzard S, McKinnon K, Asnis PD, et al. Return to sport after surgical treatment of lisfranc injuries in athletes: a retrospective case series. Kans J Med. 2019;12(4):141–5.
52. Wadsworth DJS, Eadie NT. Conservative management of subtle lisfranc joint injury: a case report. J Orthop Sports Phys Ther. 2005;35(3):154–64.
53. Wagner E, Ortiz C, Villalón IE, Keller A, Wagner P. Early weight-bearing after percutaneous reduction and screw fixation for low-energy lisfranc injury. Foot Ankle Int. 2013;34(7): 978–83.
54. Walley KC, Semaan DJ, Shah R, Robbins C, Walton DM, Holmes JR, et al. Long-term Follow-up of lisfranc injuries treated with open reduction internal fixation patient-reported outcomes. Foot Ankle Orthop. 2021;6(3):24730114211039496.

55. Wixted CM, Luo EJ, Stauffer TP, Wu KA, Adams SB, Anastasio AT. Biomechanical profile of varying suture button constructs in cadaveric specimens: a systematic review and meta-analysis. Ann Transl Med. 2023;11(10):344.
56. Yi Y, Chaudhari S. Various flexible fixation techniques using suture button for ligamentous lisfranc injuries: a review of surgical options. Medicina (Mex). 2023;59(6):1134.
57. Yongfei F, Chaoyu L, Wenqiang X, Xiulin M, Jian X, Wei W (2021) Clinical outcomes of Tightrope system in the treatment of purely ligamentous Lisfranc injuries. BMC Surg 21(1):395.

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