Arthrodesis Versus ORIF for Lisfranc Fractures

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abstract

Full article available online at Healio.com/Orthopedics. Search: 20120525-26

The Lisfranc joints make up the bony structural support of the transverse arch in the midfoot and account for approximately 0.2% of all fractures. Early recognition and treatment of this injury are paramount to preserving normal foot biomechanics and function. Controversy exists regarding the optimal treatment of patients with Lisfranc injuries, particularly when the instability is entirely ligamentous.

The authors performed a qualitative, systematic review of the literature to compare the 2 most common procedures for Lisfranc fractures: primary arthrodesis and open reduction and internal fixation (ORIF). Six articles with a total of 193 patients met the inclusion criteria. At 1-year follow-up, the mean American Orthopaedic Foot and Ankle Society score of ORIF patients was 72.5 and of arthrodesis patients was 88.0. Fisher’s exact test revealed no significant effect of treatment group on the percentage of patients who had an anatomic reduction ($P = .319$).

This study highlights that both procedures yield satisfactory and equivalent results. A slight advantage may exist in performing a primary arthrodesis for Lisfranc joint injuries in terms of clinical outcomes.

Figure: Myerson classification. Total incongruity (A). Partial incongruity (B). Divergent (C).

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doi: 10.3928/01477447-20120525-26
The Lisfranc joints make up the bony structural support of the transverse arch in the midfoot. Lisfranc injuries account for approximately 0.2% of all fractures,1 with an incidence of 1/55,000 cases per year.1,2 Early recognition and treatment of this injury are paramount to preserving normal foot biomechanics and function. Approximately 20% of Lisfranc joint injuries are missed on initial anteroposterior and oblique radiographs,3 and persistent malalignment after this injury can lead to chronic pain, progressive deformity, and prolonged disability.4,5

Controversy exists regarding the optimal treatment of patients with Lisfranc injuries, particularly when the instability is entirely ligamentous.6 Although the current trend is treating these patients with open reduction and internal fixation (ORIF),6-8 those with dislocation in the absence of significant fracture continue to pose a therapeutic challenge. Despite appropriate initial treatment, up to 94% of these patients develop posttraumatic arthritis and require a conversion to an arthrodesis of the tarsometatarsal joints.9-11 Some studies report primary arthrodesis to be a salvage method,12,13 whereas others recommend it as a primary treatment.14 Because no consensus exists for managing Lisfranc fracture-dislocation variants, the authors of the current study performed a qualitative, systematic review of the literature to compare the 2 most common procedures for Lisfranc fractures: primary arthrodesis and ORIF. Review of radiographic reduction and patient outcomes was performed.

**Materials and Methods**

A formal review was performed of all available reports in the English literature pertaining to ORIF and primary arthrodesis (complete and partial) of the Lisfranc joints. Radiographic outcome assessment included final or postoperative anatomic reduction based on ≥1 of the following radiological findings: diastasis between the first and second metatarsals or meta-tesarsocuneiform joint, talometatarsal angle, and the line tangential to the medial aspect of the navicular and the medial cuneiform intersecting the base of the first metatarsal. Clinical outcome assessment was determined via patient scoring based on the postoperative American Orthopaedic Foot and Ankle Society (AOFAS) midfoot scale. The purpose of the study was to compare clinical and radiographic outcomes between arthrodesis and ORIF interventions for Lisfranc injuries based on available clinical and radiologic outcomes.

**Literature Search**

A comprehensive search was performed of Medline, Cochrane Central Register of Controlled Trials, and Ovid using the key words Lisfranc, Lisfranc fracture, Lisfranc dislocation, metatarsal fracture, metatarsal dislocation, Lisfranc arthrodesis, Lisfranc ORIF, and Lisfranc open reduction internal fixation. The database search also included a search of any published report in the American Association of Orthopaedic Surgeons (AAOS) annual meeting proceedings between 2006 and 2010. To ensure that all possible articles were considered, the references of all relevant articles were manually cross-referenced to identify potential additional studies.

For a study to satisfy the inclusion criteria, it required (1) inclusion of a Lisfranc classification system according to Quenu and Kuss15 or a modification of Myerson et al2 or Hardcastle et al,16 (2) treatment within 48 hours of injury, (3) the use of 1 of the 2 treatments of interest, and (4) publication between January 1985 and September 2011 in English. All injury mechanisms were eligible for the study.

Exclusion criteria included studies that focused on a biomechanical model, review articles, articles on the pediatric population, isolated case reports, surgical technique articles, foreign language reports, studies using either closed reduction or percutaneous pinning as the primary treatment, reports of arthrodesis as a salvage or secondary procedure, and patient assessment that did not include the AOFAS midfoot score. All study designs were eligible, including randomized, controlled trials and prospectively or retrospectively nonrandomized, controlled trials.

**Statistical Methods**

Statistical analysis was performed using SPSS version 16.0 for Windows software (SPSS, Inc, Chicago, Illinois). Fisher’s exact test was performed to compare the reduction rate between the ORIF group and the arthrodesis group. Statistical significance was set at P<.05.

**Results**

The database search resulted in 1743 articles (Figure 1). After limiting the search to clinical trials in English and excluding biomechanical and surgical techniques,
case reports, imaging studies, studies not involving ORIF or arthrodesis, studies not involving the Lisfranc joint, nonoperative treatment, and duplicate reports, a total of 154 applicable reports were identified. The abstracts from the 154 articles were examined by an author (S.S.R.) to determine whether the article fit the inclusion or exclusion criteria. Each original article was reviewed to determine eligibility if this could not be determined from the abstract. From this group, 16 articles were determined to fulfill the inclusion criteria. Four articles were rejected because they combined ≥1 method of treatment. Three studies were rejected because they did not specify their requirement for anatomical reduction on radiographs. Three studies were rejected because they used patient assessment other than the AOFAS midfoot score. This left a total of 6 studies for the current review (Table 1). The studies included 8 treatment arms and a total of 193 eligible patients. Of the 6 studies, 4 focused on ORIF alone. Two studies directly compared ORIF and arthrodesis. The ORIF group comprised a total 160 eligible patients, with 152 patients undergoing the procedure and returning for follow-up. The arthrodesis group comprised 33 patients.

Six articles included data on postoperative anatomic reduction, and 4 articles provided AOFAS midfoot scores. Of 3 prospective studies, 2 included direct comparisons of ORIF and arthrodesis. One study used a randomized design, and in the remaining prospective studies, it was unclear whether the patients were randomized. Mean follow-up was 39.8 months.

Of the 6 articles that met the inclusion criteria, 4 reported AOFAS scores at 1-year follow-up. Each of these articles included patients treated with ORIF, with 1 of the 4 also reporting AOFAS scores for an arthrodesis group (Table 2). The total number of patients evaluated was 90 in the ORIF group and 21 in the arthrodesis group. At 1-year follow-up, the mean AOFAS score of ORIF patients was 72.5 and of arthrodesis patients was 88.0. By not having access to the original data sets, the authors were unable to perform a statistical analysis on AOFAS scores at 1 year between patients undergoing ORIF and arthrodesis. However, although the sample size is somewhat small for the arthrodesis group, a clinical difference between the 2 groups is evident at 1-year follow-up, with the AOFAS score for the arthrodesis group higher than that of the ORIF group.

In addition, the rate of postoperative radiographic anatomic reduction was also evaluated from the data reported by the 6 articles that met the inclusion criteria (Table 3). Combining the patient totals from these articles, a total of 146 patients were treated with ORIF. Of these, 134 (91.8%)
patients had postoperative anatomic reduction. Two of the 6 articles reported data on patients treated with arthrodesis. A total of 33 patients were included, and 28 (84.8%) had postoperative anatomic reduction. Fisher’s exact test revealed no significant effect of treatment group on the percentage on patients who had an anatomic reduction ($P=.319$).

Patient demographics were not described in all studies. Of the 193 patients across all studies, 127 were men and 66 were women. In studies in which the age of the patient population was reported, mean overall age was 29 years (range, 15-76 years). The most common cause of injury was high-energy trauma, usually a motor vehicle accident (Table 4). The most common injury type was B2 according to Myerson et al’s classification (Figure 2). More than half of the injuries were mixed osseous and ligamentous, and the remaining injuries were ligamentous.

**Surgical Technique**

Nearly all studies included in the current review used a dorsal incision technique over the first intermetatarsal space to expose the medial column joint surfaces of the midfoot. Comminuted fractures were then reduced, and smaller fragments were removed. The medial border of the base of the first metatarsal and the medial border of the first cuneiform were aligned. The base of the second metatarsal was opposed to the lateral border of the first cuneiform. The joint was held reduced with provisional Kirschner wires, then one 3.5- or 4.5-mm transarticular countersunk cortical screw was inserted from the metatarsal base proximally into the medial cuneiform. If the third metatarsal base was dislocated, a second dorsal incision was typically performed between the third and fourth metatarsals to stabilize the third metatarsocuneiform joint and enable the fourth and fifth metatarsal bases to be fully reduced. Depending on the type of fracture, the lateral (fourth and fifth) tarsometatarsal joints were generally stabilized using K-wires.

**Postoperative Care**

All studies preferred partial or non-weight bearing for at least 6 to 8 weeks postoperatively. The K-wires in the lateral column were usually removed 6 to 8 weeks postoperatively. Several authors advocated maintenance of cortical screws in the medial column unless they were a source of pain, whereas some preferred to remove the screws between 18 weeks and 6 months postoperatively.

**Complications**

Across all studies, the most common complications reported were screw breakage, posttraumatic arthritis, missed associated injuries, deep venous thrombosis, compartment syndrome, and superficial wound infection (Table 5).

**DISCUSSION**

Prompt recognition and treatment of tarsometatarsal injury is imperative to minimize the potential for significant long-term disability. A high index of suspicion is warranted for these injuries because they are frequently subtle or occult and can therefore be easily missed. When suspicion is present despite the absence of identifiable abnormality on plain radiograph assessment, weight-bearing radiographs and stress view examinations are recommended. General agreement exists in the literature that anatomic reduction of the Lisfranc joint is important for optimal outcome. Adib et al found a significant difference between anatomic reduction and the development of osteoarthritis. In patients with anatomic reduction, 35% developed osteoarthritis, compared with 80% of those who had nonanatomic reduction.

However, no general consensus exists as to the best method of treatment for patients with Lisfranc injuries, aside from agreement that closed reduction is unsuccessful in the majority of cases given the inherent instability associated with this injury pattern. Closed reduction and casting provides neither proper restraint against further displacement nor removal of interposed soft tissue structures that often impede anatomic reduction. Long-term outcome after Lisfranc injury appears to be related to the accuracy of reduction. The current review is the first systematic review of literature comparing both anatomic reduction and clinical outcomes with respect to ORIF and primary arthrodesis in Lisfranc injuries. A previous systematic review of the literature has been performed, with several limitations. Unlike the previous review, the current review stratified fractures according to a well-accepted classification system and compared anatomic reduction and clinical outcomes based on 1 accepted parameter of interest.

Open reduction and internal fixation is currently the most common treatment for displaced Lisfranc joint injuries. The **Table 4**

<table>
<thead>
<tr>
<th>Mechanism of Injury</th>
<th>Occurrence, %</th>
</tr>
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<tbody>
<tr>
<td>Motor vehicle accident</td>
<td>57</td>
</tr>
<tr>
<td>Fall from height</td>
<td>21</td>
</tr>
<tr>
<td>Sports related</td>
<td>9</td>
</tr>
<tr>
<td>Work related</td>
<td>8</td>
</tr>
<tr>
<td>Crush injury</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table 5**

<table>
<thead>
<tr>
<th>ORIF Group</th>
<th>Arthrodesis Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw breakage</td>
<td>Pseudarthrosis</td>
</tr>
<tr>
<td>Posttraumatic OA</td>
<td>Painful hardware</td>
</tr>
<tr>
<td>DVT</td>
<td>Nonunion</td>
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<tr>
<td>Compartment syndrome</td>
<td>Delayed union</td>
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<tr>
<td>Superficial infection</td>
<td></td>
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<tr>
<td>Missed associated injury</td>
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Abbreviations: DVT, deep venous thrombosis; OA, osteoarthritis; ORIF, open reduction and internal fixation.
treatment of complete ligamentous injuries poses a therapeutic challenge for most surgeons. Even with anatomic reduction, treatment of these injuries does not produce consistently satisfactory outcomes. Between 40% and 94% of these patients develop posttraumatic arthritis, requiring conversion to arthrodesis. Previous studies have reported the reoperation rate in the ORIF group to be between 75% and 79%, compared with 17% to 20% in the arthrodesis group.

The variation in the rate of arthrosis across multiple studies suggests that the injury itself, rather than any particular chosen treatment, has the greatest influence on outcome. In a recent prospective, randomized study by Henning et al., patients treated with ORIF had a higher rate of additional surgery compared with those treated with primary arthrodesis (79% vs 17%, respectively; P<.05). The primary arthrodesis group trended toward better Short Musculoskeletal Functional Analysis scores than the ORIF group. In the current review, no apparent differences existed between ORIF and primary arthrodesis in terms of anatomic reduction. This review also revealed that the mean AOFAS score was higher in the primary arthrodesis group at 1-year follow-up for pure ligamentous and combined bony and ligamentous injuries. The current study’s data support primary arthrodesis as a primary treatment for Lisfranc joint injuries due to a significantly decreased rate of additional surgeries, as well as a tendency toward improved clinical outcome scores when compared with ORIF.

The most common complications across all studies were screw breakage and posttraumatic arthritis (Table 5). A total of 3 patients were noted to develop compartment syndrome requiring fasciotomy, suggesting that this is a somewhat unusual clinical event after Lisfranc injury. It is postulated that the incisions and anatomic reduction decompress the midfoot and decrease the likelihood of compartment syndrome. One patient in the arthrodesis group was found to develop nonunion requiring revision arthrodesis with bone graft from the calcaneus; the fusion healed uneventfully. It was postulated that the high fusion rate after primary fusion may be due to the hyperemia that follows the severe injury, although it is suspected that surgeon experience also plays a role. Similarly, a patient with delayed union received treatment with a bone stimulator and proceeded to union within 8 weeks. Given the fact that the nonunion rate was low in the arthrodesis group, this may be a factor in deciding to proceed with primary arthrodesis rather than ORIF. Approximately 25% of patients in the arthrodesis group developed asymptomatic degenerative joint disease, which required no further surgery.

A strength of the current systematic review was the clear objective set forth at the start of the study to eliminate selection bias. The article search using electronic databases and manual bibliography searches was comprehensive and repeated by 3 authors (S.S.-R., C.D., M.R.G.). The protocol was strictly adhered to, and all potential articles had to be agreed on by several authors (S.S.-R., C.D., M.R.G.). Despite the strengths of the current study, weaknesses existed in the literature. First, the AOFAS midfoot score is not a validated tool. This scale was chosen because it was the most common method of outcome assessment in the literature. Second, some studies did not provide key data elements, including individual patient AOFAS scores. An attempt was made to contact the authors of those studies to retrieve individual patient scores without success. One study used the AOFAS midfoot score to measure clinical results for patients treated with primary arthrodesis. Thus, the current authors were unable to statistically compare the ORIF and primary arthrodesis groups.

Few articles report prospective studies; 2 articles report the primary arthrodesis procedure. Given the nature of the current systematic review, a priori power analysis is unjustified. Fisher’s exact test was used to give an exact P value for the measure of statistical difference. The relatively small number of arthrodesis patients (n=33) still surpasses the acceptable sample size of 30 for sufficient power for Fisher’s exact test, as well as for accepted interpretation of statistical results. The large sample of ORIF patients lends itself to be viewed as a truer representation of the actual population, yet the current authors claim that while comparing this with a group of 33 patients, the nonsignificant finding ascertained by Fisher’s exact test gives a statistically valid interpretation of the differing (or nondiffering, in this case) rates of anatomic reduction.

Figure 2: Myerson classification. Total incongruity (A). Partial incongruity (B). Divergent (C).
CONCLUSION
This study provides evidence that ORIF and arthrodesis yield satisfactory and equivalent results. A slight advantage may exist to performing a primary arthrodesis for Lisfranc joint injuries in terms of clinical outcomes. Although not all patients are candidates for primary arthrodesis, it should be considered for those with complete ligamentous injuries. Further prospective studies with direct comparisons of the 2 procedures are needed. In the future, a validated scoring system such as the Visual Analog Scale Foot and Ankle should be used.

REFERENCES