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AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY

Foot & Ankle International®
2020, Vol. 41(1) 31–36

DOI: 10.1177/1071100719873846
journals.sagepub.com/home/fai

Comparison of Complication and Reoperation Rates for Minimally Invasive Versus Open Cheilectomy of the First Metatarsophalangeal Joint

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Abstract

Background: Dorsal cheilectomy of the first metatarsophalangeal joint is an accepted treatment to alleviate dorsal impingement, pain, and reduced dorsiflexion in hallux rigidus. Traditionally performed via an open incision, this procedure has more recently been performed using minimally invasive techniques despite limited supportive published evidence.

Methods: From December 2012 through December 2017, a retrospective analysis of all cheilectomies performed in our institution was done. The surgical technique was recorded along with any subsequent procedures performed for either persistent or recurrent pain, and complications were also noted. A comparison between open and minimally invasive outcomes was performed. In total, 171 cheilectomies were performed during this period. There were 38 open and 133 minimally invasive procedures.

Results: At a mean 3-year follow-up, the reoperation rates of the 2 groups were different with only 1 (2.6%) of the open group requiring a fusion, while 17 (12.8%) of the minimally invasive surgical (MIS) group required further surgery (relative risk, 4.86; $P = .059$). In the open group, there was 1 (2.6%) complication, compared with 15 (11.3%) in the minimally invasive group (relative risk, 4.29; $P = .076$).

Conclusion: While patients may opt for MIS cheilectomy with a proposed faster recovery time and better cosmesis, they should be counseled about the risks and benefits of both methods, and that the technique of MIS cheilectomy utilized in this study appears to have an increased relative risk of requiring a further procedure.

Level of Evidence: Level III, retrospective comparative series.

Keywords: cheilectomy, hallux, MIS, minimally invasive

Introduction

Nonoperative treatment options for dorsal impingement pain from hallux rigidus include simple analgesia, avoiding shoes with a high heel, footwear with a deep toe box, rocker bottom or stiff-soled footwear, or an orthotic with a Morton's extension under the hallux.[21] In the event of failure of these measures, there are numerous operative joint-sparing options that can be considered. These range from cheilectomy to proximal phalangeal and/or first metatarsal osteotomies. A traditional open dorsal cheilectomy involves removing dorsal osteophytes from both the metatarsal and phalangeal side of the joint, and up to 30% of the joint surface, in order to achieve dorsiflexion of greater than 45 degrees.[6] Studies have repeatedly demonstrated good efficacy and few complications for cheilectomy.[3,10,17,20] The advantages of an open approach are that it allows direct visualization of the joint surfaces, can address chondral

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defects, and allows for an extensive soft tissue release. The perceived disadvantages are a larger soft tissue insult and the need to protect the wound from early mobilization until it is healed.

A minimally invasive surgical (MIS) technique for performing cheilectomy was first documented in the literature in 2008.[14] The main perceived advantage of this technique is that it lessens the insult to the soft tissues, leading to earlier postoperative mobilization and quicker return to function. In spite of the increasing popularity of minimally invasive techniques, only a few small, short-term studies exist that demonstrate, at best, equivalence to open techniques.[4,12,14,15] A recent study has provided much more robust data about the outcomes and complications from MIS cheilectomy.[23]

This study was initiated by an observed apparent difference in the number of postoperative complications and the need for further surgery between open and MIS cheilectomy techniques. The aim of this study was to retrospectively evaluate our experience for a cohort of consecutive dorsal cheilectomies performed in our unit since minimally invasive techniques were introduced in 2012.

Methods

A retrospective search of electronic operative records using CCSD and OPCS codes for the word "cheilectomy" identified a cohort of patients between June 1, 2012, and June 1, 2018. Having identified this cohort of patients, the need for further operative intervention and complications of surgery was readily identifiable by further searching the patient databases. In total, 171 consecutive dorsal cheilectomies for treatment of dorsal impingement pain in hallux rigidus were performed. Of these, 133 were performed using MIS techniques and 38 were open procedures (Table 1). Any concomitant surgical procedures to the cheilectomy did not preclude the case from being reviewed in the study. All procedures were performed by 5 consultant orthopedic foot and ankle surgeons (C.C., H.D., M.F., C.B., and M.D.), all experienced with both operative treatment methods. All of them had undergone formal cadaveric training in MIS cheilectomy in 2012 by the UK pioneers of the technique (Redfern and Vernois).[18] This retrospective review was performed by a member of the team not involved with any of the procedures.

In total, 171 procedures were performed: 133 MIS procedures and 38 using an open approach. The mean age was the same for both groups: 54 (range, 17-99) years for the MIS group and 54 (range, 24-87) years for the open group. The mean length of time since surgery was also similar: 36 (range, 6-74) months for the MIS group and 34 (range, 6-71) months for the open group (Table 2).

Table 1. Breakdown of Procedures Performed on Each Patient.

Procedure Performed	No. of Patients
Open cheilectomy alone	23
Open cheilectomy and another ipsilateral foot procedure	15
MIS cheilectomy alone	125
MIS cheilectomy and another ipsilateral foot procedure	8

Abbreviation: MIS, minimally invasive surgical.

Table 2. Demographic Details for Both Groups.

	MIS	Open
No. of patients	133	38
Mean age (range)	54 (17-99)	54 (24-87)
Mean follow-up	3 y 0 mo	2 y 10 mo

Abbreviation: MIS, minimally invasive surgical.

Technique

Whenever palpable, the dorsal medial cutaneous nerve (DMCN) was marked preoperatively on the skin. The MIS technique involved a small stab incision on the dorsomedial aspect of the first metatarsophalangeal joint (1MTPJ), parallel to the extensor tendon, 1 cm proximal to the 1MTPJ. A potential space for accessing the dorsal osteophytes was developed with an elevator followed by a standard portal proximal to the 1MTPJ and, if required, an accessory portal distal to the 1MTPJ. Debridement of the dorsal osteophyte was performed using a cooled 3.1 × 13–mm wedge burr (Wright Medical, Memphis, TN). The debridement proceeded until sufficient dorsiflexion had been achieved. A mini C-arm provided intraoperative information as to the extent of the debridement. Copious lavage of the joint through the portals was used to flush away bone debris until the effluent was clear and no bone debris was left in the portal. The wounds were closed with adhesive paper dressing strips, gauze, and bandaging. Patients were encouraged to bear weight in a stiff-soled postop shoe. At around day 7 postoperatively, all dressings were removed and range of motion exercises were commenced.

In contrast, the open technique involved a longitudinal, dorsal skin incision allowing access to the 1MTPJ immediately medial to the extensor hallucis longus (EHL) tendon. In all cases, a dorsomedial approach was avoided in order to minimize the risk of injury to the DMCN.[22] Debridement of the dorsal osteophytes from both sides of the joint was then performed using a combination of saw, rongeurs, and osteotomes. Up to 30% debridement of the dorsal aspect of the first metatarsal head was also performed. If impaired, the mobility of the sesamoid apparatus was also improved using a McGlamry elevator until sufficient dorsiflexion was

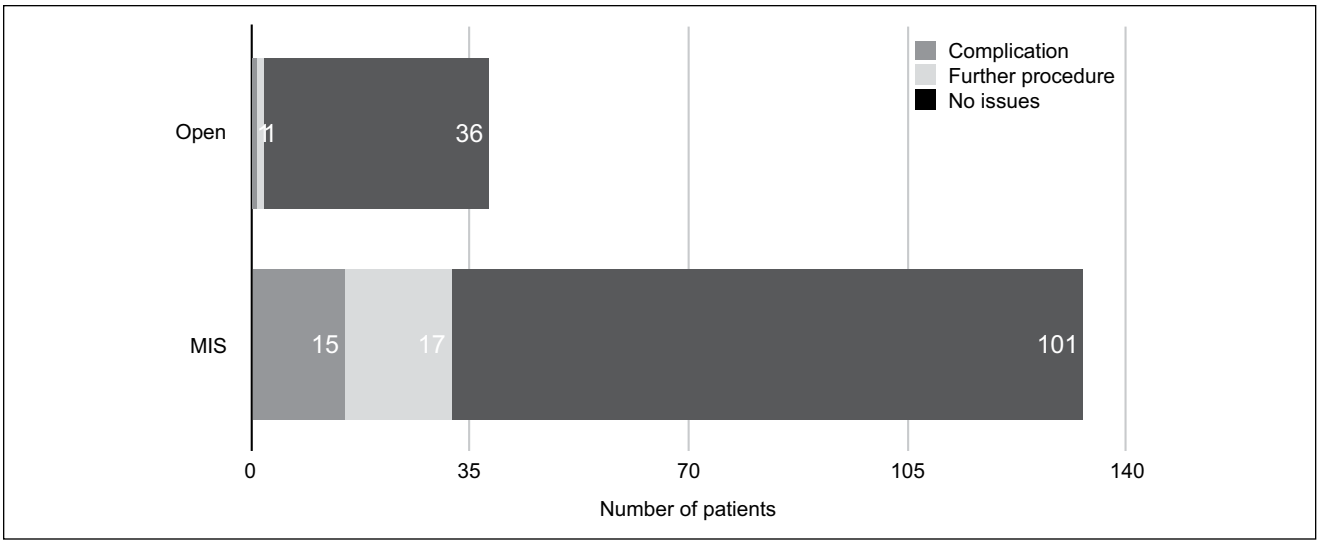

Figure 1. Bar chart demonstrating the number of further procedures and other complications in each group. MIS, minimally invasive surgical.

achieved. The wounds were closed with absorbable sutures in layers and dressed with nonadhesive dressing gauze, wool, and a crepe bandage. Patients were encouraged to bear weight in a flat dressing shoe. At 14 days, all dressings were removed and range of motion exercises were commenced.

The data collected underwent statistical analysis using SPSS Statistics for Windows Version 25.0 (IBM Corp., Armonk, NY). The relative risk of requiring further procedures or having a complication was calculated, with an equivalence test of the log of the relative risk being used to test for significance ($P < .05$). In an attempt to determine evidence of a learning curve over the 6 years of the study, the MIS group was subdivided into 3 cohorts. Each 2-year cohort allowed comparison of outcome from the earliest 2 years, the middle 2 years, and the most recent 2-year period. The cohorts provided sufficient numbers in each cohort for statistical analysis with application of Fisher's exact test to identify any difference in reoperation rate.

Results

At a mean follow-up of almost 3 years, a larger proportion of the MIS group required a further procedure (17 [12.8%] vs 1 [2.6%]; relative risk, 4.86; $P = .059$) (Figure 1). There were other patients who had complications that did not require a further procedure (Figure 1 and Table 3). Similarly, the proportion of patients affected by complications of surgery was higher in the MIS group (15 [11.3%] vs 1 [2.6%]; relative risk, 4.29; $P = .076$).

Subdivision of the MIS group based on time since surgery and comparison of revision rates between each time group using Fisher's exact test revealed no evidence of a learning curve ($P = .313$) (Figure 2). Also, no significant difference was detected between the 5 operating surgeons and their outcomes regarding postoperative complications or reoperation rate.

Table 3. Further Procedures Performed on Patients and Complications Not Requiring Further Intervention.

	MIS	Open
Further Procedure		
1MTPJ arthrodesis	9	1
Open cheilectomy	3	
MIS cheilectomy	2	
Interposition arthroplasty	1	
Hallux valgus correction	2	
Complication		
Wound infection		1
Residual pain, not wanting further surgery	5	
Residual stiffness	2	
Delayed wound healing	2	
Ectopic bone in wound	2	
CRPS/neuropathic pain	2	
Extensor hallucis longus rupture	1	
Dorsomedial cutaneous nerve injury	1	

Abbreviations: 1MTPJ, first metatarsophalangeal joint; CRPS, complex regional pain syndrome; MIS, minimally invasive surgical.

Discussion

Historically, many authors have relied on a radiographic grading system (Coughlin and Shurnas[3]) to determine patient suitability for cheilectomy,[5,7,9] with divided opinion on whether cheilectomy is an appropriate method of treatment for the most severe Coughlin grades.[7,8,11] However, a recent study by Baumhauer et al[1] demonstrated that the radiographic grading system did not correlate with the

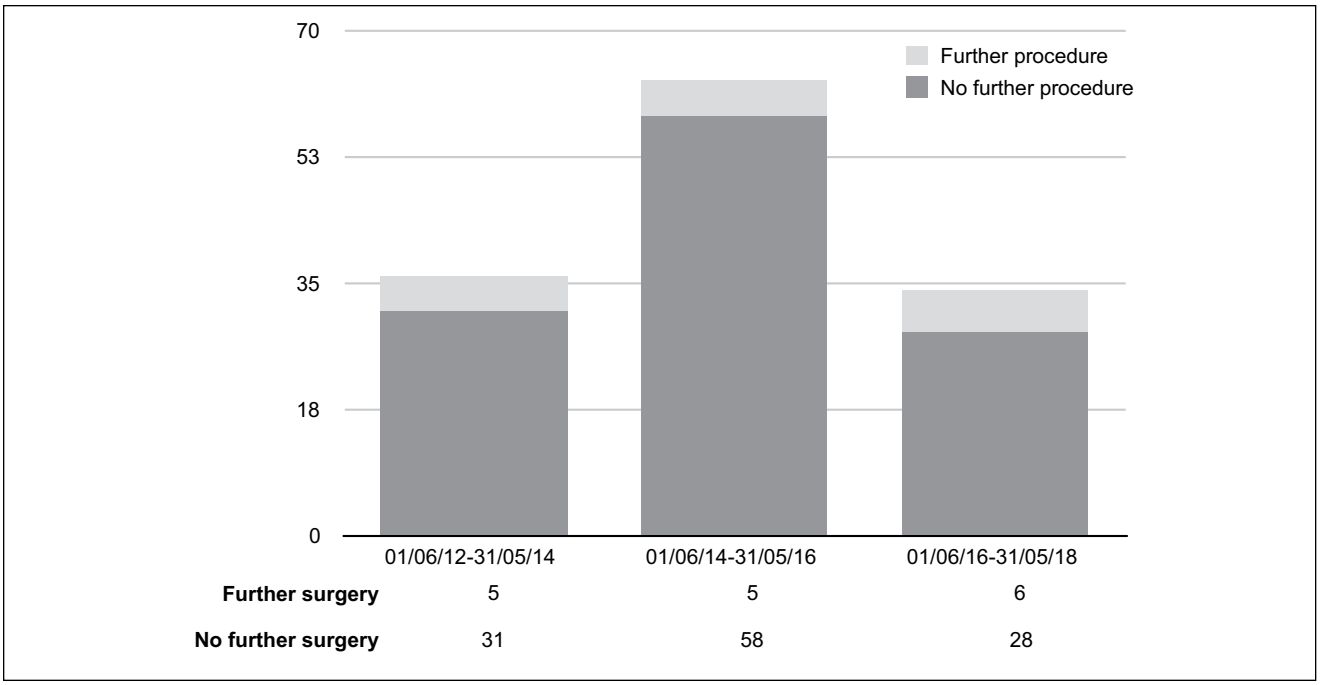

Figure 2. Bar chart demonstrating the number of further procedures required in the minimally invasive surgical (MIS) group, with the group subdivided into 2-yearly cohorts.

severity of disease noted intraoperatively. Therefore, for the purposes of this study, no radiographs were graded and the decision for cheilectomy was largely based on clinical assessment. Indications for a dorsal cheilectomy in early 1MTPJ arthrosis include a prominent dorsal osteophyte, impingement pain on dorsiflexion, reduced dorsiflexion, pain on passive plantarflexion, and the absence of pain in the midrange of available motion. With suitable patient selection, open cheilectomy has been proven to be successful and safe,[2,3,19,24] and patient satisfaction with the open procedure is reported at over 90%.[3,7,13]

Dorsal cheilectomy, utilizing MIS techniques, has become increasingly popular in foot and ankle surgery, with the desire to minimize soft tissue morbidity and hasten recovery times. In a recent study of MIS dorsal cheilectomies, patients reported substantial improvement in outcome measures with this technique.[23] However, unlike this study, they did not compare outcomes to those achieved using existing techniques in their unit. Similar findings were observed in another smaller study assessing the results of MIS dorsal cheilectomy, although it is difficult to offer meaningful comparisons since in that paper the MIS dorsal cheilectomy was always combined with a MIS proximal phalangeal osteotomy and often involved a shortening first metatarsal Weil osteotomy.[14] The present study compares larger numbers of dorsal cheilectomies performed by both MIS and open methods with a mean follow-up of 3 years.

As with any operative procedure, failure to achieve the desired outcome may be related to poor patient selection, poor operative technique, or a complication. Open dorsal cheilectomy is a straightforward technique where failure to relieve symptoms is reported in 8% to 10% of patients.[3,7,13] In the present study, none of the patients undergoing open dorsal cheilectomy procedures required further surgery for dorsal impingement pain. Correspondingly, with MIS dorsal cheilectomy, using the technique advocated by Redfern et al,[18] the sole study in the literature with a relatively large number of patients[23] identified a failure to relieve symptoms in 12% of cases, with 4% requiring further dorsal cheilectomy surgery for dorsal impingement pain. These results from Teoh et al[23] reflect the findings of the present study, in which 3.8% (5/133) of patients had to undergo a further dorsal cheilectomy.

Poor execution of an operative technique is more likely when surgeons start using a new operative technique, especially if it is technically challenging. This is acknowledged as a "learning curve." Within the literature, there are no references to a learning curve for performing an open dorsal cheilectomy, but it is readily accepted as being a straightforward operative technique. In the study by Teoh et al,[23] the technique for MIS dorsal cheilectomy appears to be subject to a learning curve. This was assessed by 2 endpoints: (1) attributing 42% of the cases requiring reoperation to poor technique and (2) observing a decreasing intraoperative fluoroscopic screening time as the case series progressed

chronologically. In the present study over a 6-year period, no demonstrable learning curve appears to have existed since when comparing the 2-yearly cohorts, there was no significant variation in the reoperation rate ($P = .313$). Additionally, the number of complications was equally spread across the 5 consultant surgeons.

In the present study, we compared the need for further surgery between the group undergoing open dorsal cheilectomy and the group undergoing MIS cheilectomy. Of those treated with an open dorsal cheilectomy, 2.6% (1/38) proceeded to further surgery, namely 1MTPJ arthrodesis. The results of this study concur with those of several studies in the literature that document from 0% to 8.8% of cases of open cheilectomy requiring 1MTPJ arthrodesis.[7,13,17,19] In comparison, 12.8% (17/133) of the MIS cheilectomy group needed further surgery. The second surgery was for intrinsic 1MTPJ pain and stiffness in 7.5% (10/133) of cases, with 9 proceeding to 1MTPJ arthrodesis and 1 case proceeding to interposition arthroplasty with a hydrogel implant. The reoperation rate of 12.8% following MIS procedures represents a similar rate to that already reported in the literature.[23] However, it is higher than the highest reported reoperation rate for open procedures (8.8%).[16] Moreover, this is significantly higher than our reoperation rate employing open techniques (2.7%; relative risk increase, 4.86; $P = .059$). The P value of .059 provides moderate to good evidence that the proportion requiring a further procedure was significantly higher in the MIS group than in the open group.

Comparison of the numbers of complications between the 2 treatment groups in this study shows an overall rate of complications of 2.6% in the open dorsal cheilectomy group versus 11.3% in the MIS group. Given that the principal objective behind MIS operative techniques is to minimize the insult to the soft tissue envelope, we found no difference in wound problems between the 2 groups (2.6% [1/38] vs 3.0% [4/133]). Of note, all 4 wound problems in the MIS group were related to residual bone particles—a recognized issue with MIS techniques where large quantities of debris need to be expelled through such small incisions. There were 2 complications specific to the MIS technique (EHL rupture and DMCN injury), both of which are readily avoidable using open surgery through a dorsal or midmedial approach.[22]

One major drawback of the study is that no patient-reported outcome measures were recorded pre- or postoperatively. Rather than focus on the negative aspects of both techniques, this would have provided a complete comparison between the 2 operative techniques. In the open group, it was difficult to perform meaningful statistical analysis given that there was only a single case requiring further surgery. Additional drawbacks relate to the retrospective nature of data collection. For example, it was not clear from the case note review how each surgeon selected when to perform one operative technique over another and whether a bias was introduced, for example, if a surgeon felt that removal of a large loose body might not be feasible using MIS techniques. This may also account for the discrepancy in the group sizes of the 2 operative techniques. There may also have been some selection bias in the early stages due to the natural tendency to try new techniques. In the final, 2-yearly cohort of MIS procedures, there was a reduction in number; whether this reflects an acknowledgment of potential issues and further selection bias by the operating surgeons is unclear. As a result, we acknowledge that we have been unable to determine whether the threshold for operation was different in the 2 groups. Further prospective research comparing the groups may ultimately address this deficiency.

Conclusion

Our experience suggests that patients should be counseled about the risks and benefits of each method of performing dorsal cheilectomy and that the technique of MIS cheilectomy utilized in this study appears to have an increased relative risk of requiring a further procedure.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Howard Davies, BSc, FRCS(Orth), Christopher Blundell, MD, FRCS(Orth), and Mark Davies, BM, FRCS(Orth), report personal fees from Wright Medical, outside the submitted work. ICMJE forms for all authors are available online.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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