Technical Note

Modified Endoscopic Distal Soft Tissue Procedure (mEDSTP) and Arthroscopic Lapidus Arthrodesis for Correction of Severe Hallux Valgus

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Abstract: Hallux valgus is one of the most common forefoot deformities faced by foot and ankle surgeons. Symptomatic deformity usually needs surgical correction. Endoscopic techniques of hallux valgus correction have been reported that are based on the same principle of the classic distal soft tissue procedure. Recently, the technique has been modified to include reconstruction of the medial metatarsosesamoid ligament and augmentation of the intermetatarsal ligament. In severe deformity or the presence of hypermobility or painful degeneration of the first tarsometatarsal joint, Lapidus arthrodesis of the joint is indicated. Arthroscopic Lapidus arthrodesis has been reported to reduce the complications associated with open procedure, including first metatarsal shortening, metatarsal elevatus, and nonunion. In this technical note, the technical details of a combined modified endoscopic distal soft tissue procedure and arthroscopic Lapidus arthrodesis is described. This is a minimally invasive approach for correction of severe hallux valgus deformity, especially that associated with ligamentous laxity.

Hallux valgus is one of the most common forefoot deformities faced by foot and ankle surgeons. Symptomatic deformity usually needs surgical correction. The aim is to correct the various components of the hallux valgus deformity.[1] However, it is inconclusive which is the best surgical option.[1] In recent years, many minimally invasive approaches have been popularized because of the potential advantages of better cosmetic outcome, less postoperative pain, and faster recovery.[1-3] Endoscopic techniques of hallux valgus correction have been reported that are based on the same principle of the classic distal soft tissue procedure.[4-14] Recently, the technique has been modified to include reconstruction of the medial metatarsosesamoid ligament and augmentation of the intermetatarsal ligament. In severe deformity or the presence of hypermobility or painful degeneration of the first tarsometatarsal joint, Lapidus arthrodesis of the joint is indicated. Arthroscopic Lapidus arthrodesis has been reported to reduce the complications associated with open procedure including first metatarsal shortening, metatarsal elevatus, and nonunion.[15-21] The purpose of this technical note is to describe the combined technique of a modified endoscopic distal soft tissue procedure and arthroscopic Lapidus arthrodesis for correction of severe hallux valgus deformity. It is indicated for symptomatic severe hallux valgus deformity, especially those associated with ligamentous laxity. It is contraindicated in patients with hallux valgus caused by bony deformity; when the intermetatarsal space cannot be closed up manually; when associated

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received May 14, 2023; accepted June 23, 2023.

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2212-6287/23725

https://doi.org/10.1016/j.eats.2023.06.006

Table 1. Indications and Contraindications

Indications
Symptomatic severe hallux valgus deformity especially associated with ligamentous laxity.
Contraindications
Hallux valgus due to bony deformity
The intermetatarsal space cannot be closed up manually
Associated significant shortening of the first metatarsal
Fixed deformity of the first tarsometatarsal joint.
Hallux valgus with the medial collateral (metatarsophalangeal) ligament as primary structure of failure (e.g., traumatic hallux valgus deformity in which the intermetatarsal angle is relatively preserved)
If other concomitant open medial column procedure is needed

with significant shortening of the first metatarsal and with fixed deformity of the first tarsometatarsal joint. It is also contraindicated in hallux valgus with the medial collateral (metatarsophalangeal) ligament as the primary structure of failure (e.g., traumatic hallux valgus deformity in which the intermetatarsal angle is relatively preserved) or if another concomitant open medial column procedure is needed (Table 1).[21-24]

Technique

Preoperative Planning and Patient Positioning

The severity of hallux valgus deformity and the mobility of the first metatarsophalangeal and first tarsometatarsal joints are examined. There is no consensus on either the direction or amount of movement of the first metatarsal in the definition of hypermobility of the first tarsometatarsal joint, and the relocation Drawer test is useful to predict the necessity of first tarsometatarsal arthrodesis.[11,25] Standing radiography of the foot is taken to assess the degree of deformity and the presence of any bony abnormalities (e.g., abnormal distal metatarsal articular angle, hallux valgus interphalangeus, or os intermetatarseum). Any associated osteoarthritis of the first metatarsophalangeal and first tarsometatarsal joints should also be noted (Fig 1). The presence of plantar gapping of the first tarsometatarsal joint on weightbearing lateral radiographs implies hypermobility of the joint.[26]

The patient is in the supine position with the legs spread. An ipsilateral thigh tourniquet is used to provide a bloodless surgical field. Fluid inflow is driven by gravity, and an arthro-pump is not used. A 2.7-mm, 30° arthroscope (Henke Sass Wolf GmbH, Tuttlingen, Germany) is used for this procedure.

Portal Placement

The modified distal soft tissue procedure is performed via the toe web, plantar, proximal, and distal bunion portals. The distal bunion portal is at the midpoint of the medial side of the first metatarsophalangeal joint. The proximal bunion portal is at the medial epicondyle region of the first metatarsal head. The toe web portal is

Fig 1. Radiograph of the illustrated case shows severe hallux valgus deformity with dislocation of sesamoid bones. SB, sesamoid bones.

at the dorsum of the first toe web. The plantar portal is in the sole between the first and second metatarsals at the level of the first tarsometatarsal joint. The plantar portal is created by inside-out technique. A 3 mm longitudinal skin incision is made at the dorsum of the first toe web. The subcutaneous tissue is bluntly dissected down to the intermetatarsal ligament by a hemostat. The dorsal surface of the ligament is cleared from the surrounding soft tissue by means of the hemostat. An arthroscope-trocar (Henke Sass Wolf GmbH) is introduced via the toe web portal and advanced proximally along the dorsal surface of the ligament to the plantar aponeurosis at the level of first tarsometatarsal joint. The aponeurosis is pierced, and a 3 mm longitudinal skin incision is then made over the trocar tip to create the plantar portal.[14] The trocar is exited through the plantar portal, and the arthroscope-cannula is introduced along the trocar via the plantar portal and advanced distally to the toe web portal. The

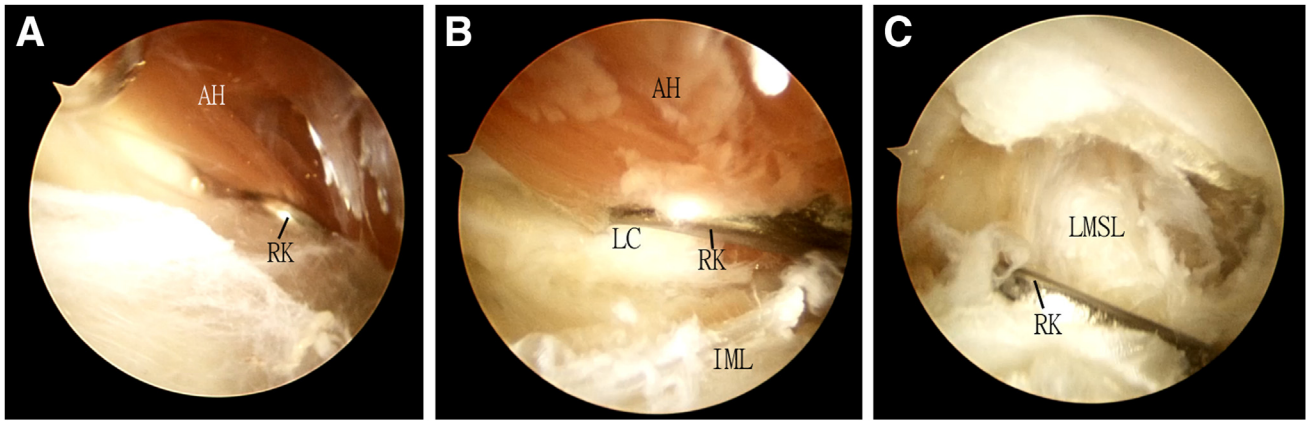

Fig 2. The plantar portal is the viewing portal and the toe web portal is the working portal. (A) The adductor hallucis muscle is released from the lateral sesamoid bone with a retrograde knife. (B) The lateral capsule of the first metatarsophalangeal joint is released. (C) The lateral metatarsosesamoid ligament is released. AH, adductor hallucis; RK, retrograde knife; LC, lateral capsule of the first metatarsophalangeal joint; IML, intermetatarsal ligament; LMSL, lateral metatarsosesamoid ligament.

trocar is then removed, and the arthroscope is incorporated into the cannula. The arthroscope is withdrawn and guides the advancement of the retrograde knife (Smith & Nephew, Andover, MA) via the toe web portal into the intermetatarsal space.

The dorsomedial and plantar medial portals are used for the arthroscopic Lapidus arthrodesis, and they are located at the dorsomedial and plantar medial corners of the joint, respectively.

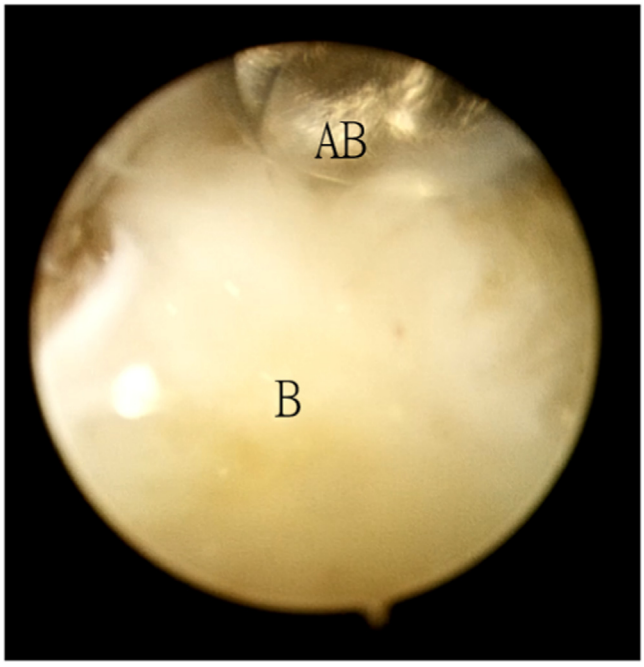

Fig 3. The distal bunion portal is the viewing portal and the proximal bunion portal is the working portal. The medial bony prominence of the metatarsal head is resected with an arthroscopic burr. B, bunion; AB, arthroscopic burr.

Supraligamentous Lateral Release

The plantar portal is the viewing portal, and the toe web portal is the working portal. The arthroscope is turned medially toward the first metatarsophalangeal joint. The adductor hallucis muscle is then in view and is traced proximally to its proximal edge. The muscle is then cut from its proximal edge distally with the retrograde knife. The cut muscle fibers will contract and retract to expose the lateral part of the first metatarsophalangeal joint and the lateral sesamoid bone. The lateral capsule of the first metatarsophalangeal joint is released by the retrograde knife starting proximal-dorsally and the run distally just dorsal to the lateral sesamoid. This can avoid injury to the interdigital nerve at the proximal end of the first metatarsophalangeal joint. The knife is expected to hit the base of the proximal phalanx in severe hallux valgus deformity, and it should be shifted laterally a bit and away from the proximal phalanx to cut the lateral phalange sesamoid and lateral metatarsosesamoid ligaments.[14] The intermetatarsal ligament is left intact (Fig 2).

Bunionectomy

The soft tissue covering the bony bunion is stripped subperiosteally by a small periosteal elevator via the proximal and distal bunion portals. The soft tissue envelop should be completely freed from the metatarsal head. The distal bunion portal is the viewing portal and the proximal bunion portal is the working portal. The medial bony prominence of the metatarsal head is resected with an arthroscopic burr (Dyonics; Smith & Nephew) (Fig 3). The resection should be focused more at the dorsomedial bony prominence because it is the usual site of bunion pain. The portals are switched to ensure adequate bone resection.

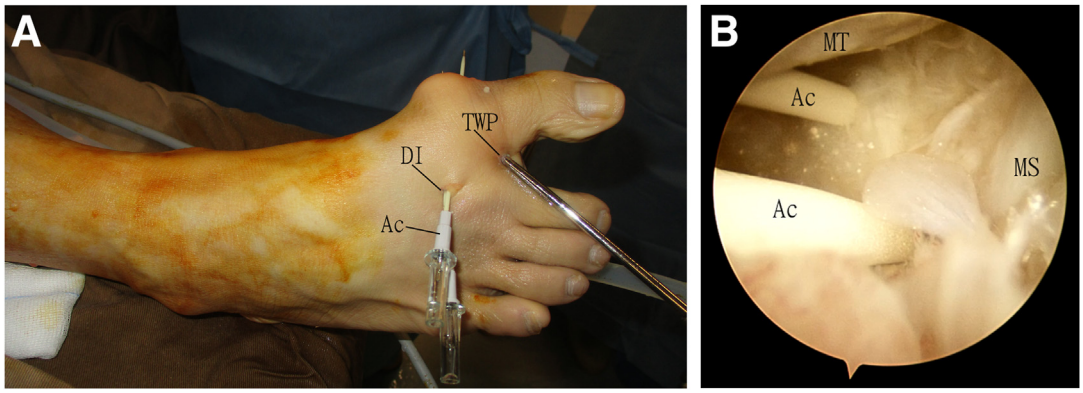

Fig 4. The toe web portal is the viewing portal and the arthroscope is inserted into the metatarsosesamoid compartment via the lateral capsulotomy site and this can distract the lateral capsulotomy site. (A) Two 16 G angiocaths are inserted from the dorsal incision to the metatarsosesamoid compartment via the lateral capsulotomy site. (B) The plantar capsule is pierced close to the lateral edge of the medial sesamoid bone and exit at the plantar-medial skin of the first metatarsophalangeal joint. TWP, toe web portal; DI, dorsal incision; Ac, angiocaths; MS, medial sesamoid; MT, first metatarsal head.

Anchoring Medial Sesamoid

A 4 mm dorsal incision is made at the medial edge of the second metatarsal neck. The toe web portal is the viewing portal, and the arthroscope is inserted into the metatarsosesamoid compartment via the lateral capsulotomy site, and this can distract the lateral capsulotomy site. Two 16 G angiocaths are inserted from the dorsal incision to the metatarsosesamoid compartment via the lateral capsulotomy site. The plantar capsule is pierced close to the lateral edge of the medial sesamoid bone and exit at the plantar-medial skin of the first metatarsophalangeal joint (Fig 4). A hemostat is inserted via

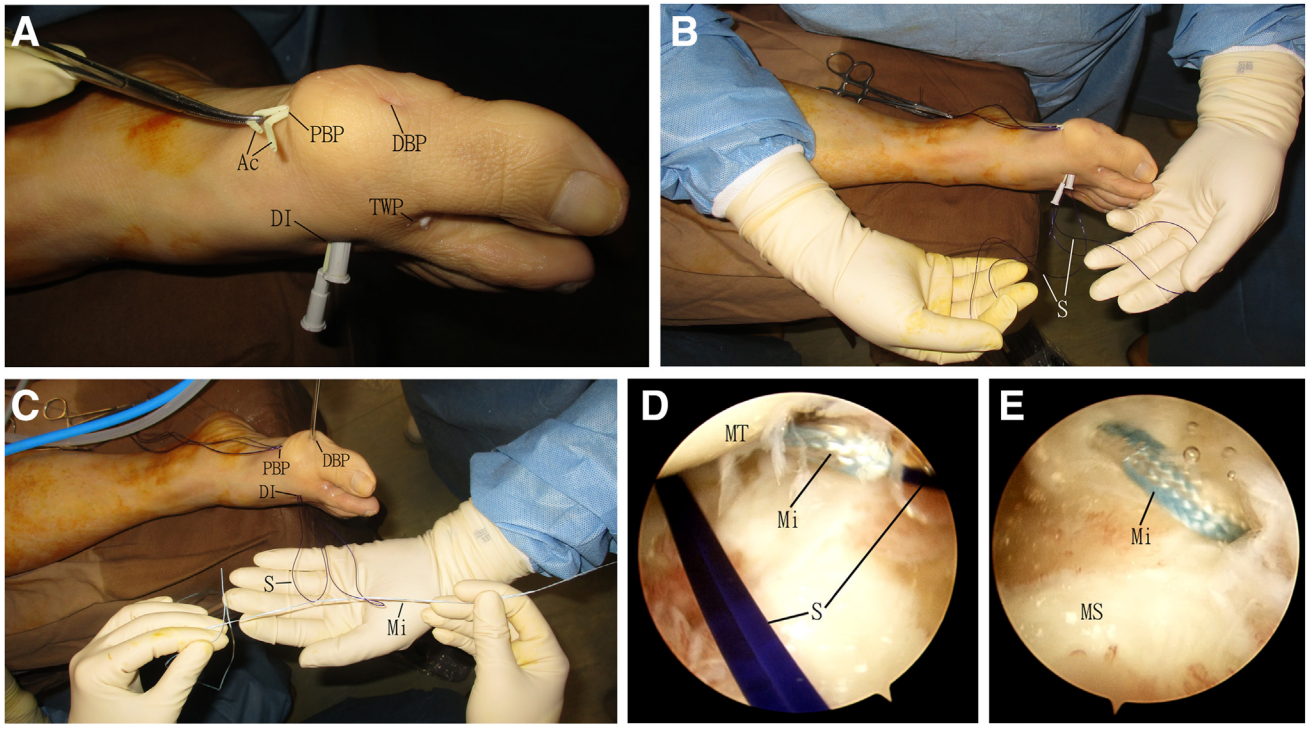

Fig 5. (A) The plastic tubes of the angiocaths are brought to the proximal bunion portal. (B) Two No. 1 PDS suture loops (Ethicon) are inserted into the tubes and pass from the dorsal incision to the proximal bunion portal. (C) The tubes are removed and the suture loops serve as suture retriever to bring the minitape (Smith & Nephew) to the lateral edge of the medial sesamoid. (D) The distal bunion portal as the viewing portal. Arthroscopic view shows the PDS suture loop brings the minitape to the metatarsophalangeal compartment. (E) The distal bunion portal as the viewing portal. The plantar capsule is anchored by the minitape. PBP, proximal bunion portal; DBP, distal bunion portal; Ac, angiocaths; DI, dorsal incision; TWP, toe web portal; S, PDS suture; Mi, minitape; MT, first metatarsal head; MS, medial sesamoid.

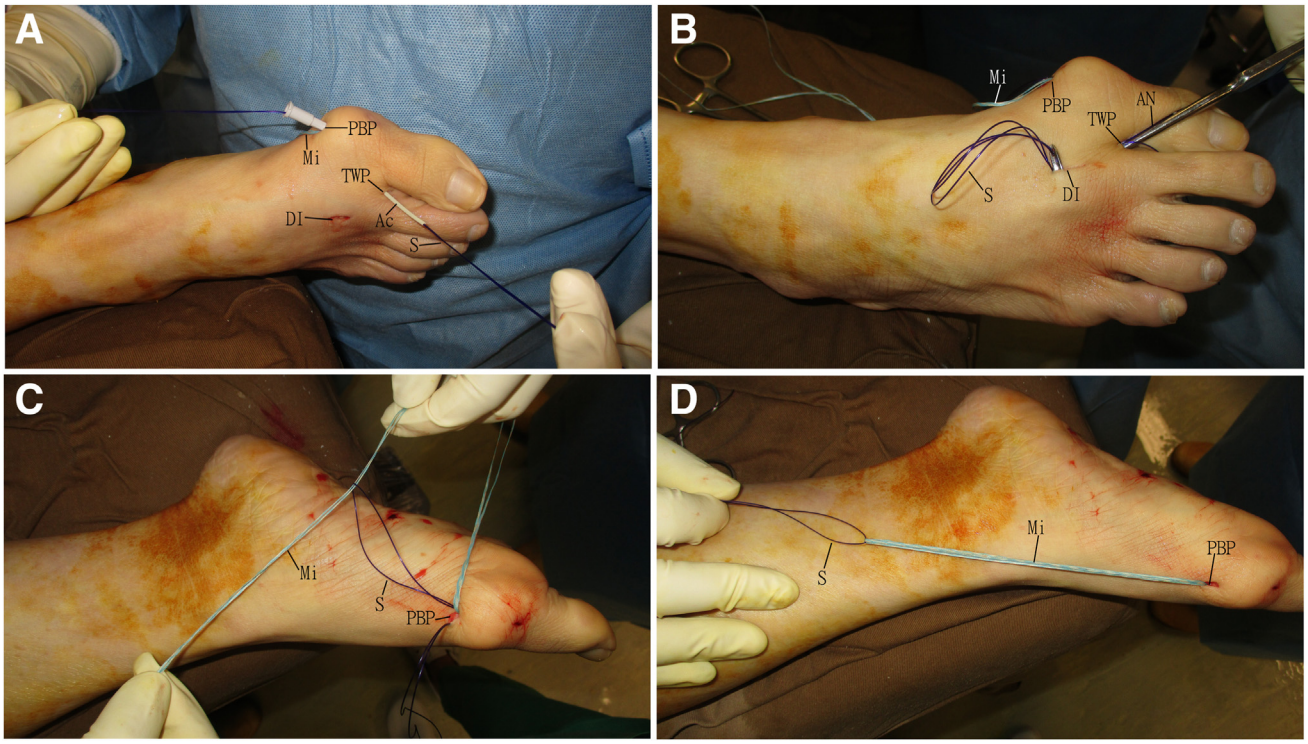

Fig 6. (A) A 16 G angiocath is inserted the intermetatarsal space via the bone tunnel of the first metatarsal neck. A hemostat is inserted via the toe web portal to grasp the angiocath gently. The core needle is withdrawn and the plastic tube is then firmed grasped and brought to the toe web portal. This serves as a conduit to pass the suture limbs of a PDS suture loop from the proximal bunion portal, through the bone tunnel and intermetatarsal space to the toe web portal. (B) The suture limbs are then brought around the second metatarsal neck to the dorsal incision by an aneurysm needle. (C, D) The suture limbs are brought back to the proximal bunion portal, dorsal to the first and second metatarsal bones and deep to the extensor tendons, by a hemostat. With the PDS suture loop used as a suture retriever, the minitape is passed through the bone tunnel, wrapped around the second metatarsal neck, and then passed dorsal to the first and second metatarsal and deep to the extensor tendons, back to the proximal bunion portal. PBP, proximal bunion portal; Ac, angiocaths; DI, dorsal incision; TWP, toe web portal; S, PDS suture; Mi, minitape; AN, aneurysm needle.

the proximal bunion portal to grasp the angiocaths gently. The core needles are withdrawn, and the plastic tubes are then firmly grasped and brought to the proximal bunion portal. Two No. 1 PDS suture loops (Ethicon, Bridgewater, NJ) are inserted into the tubes, and then the tubes are removed. The suture loops serve

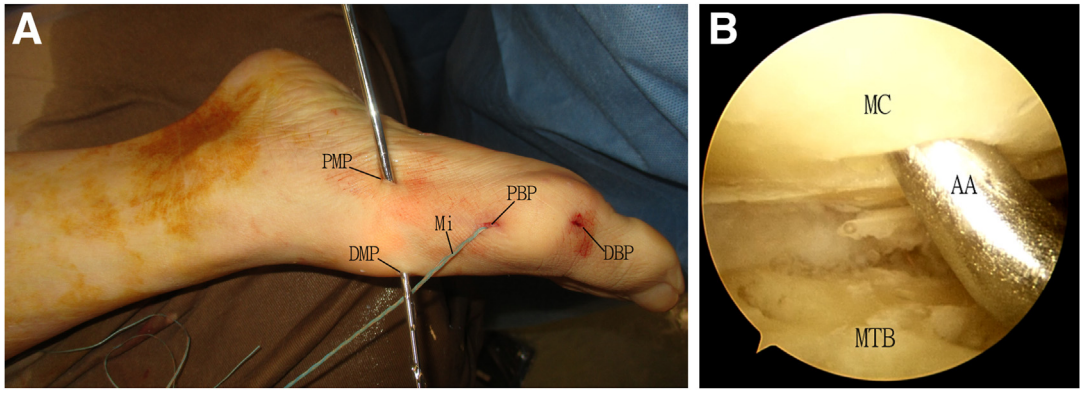

Fig 7. (A) Arthroscopic Lapidus arthrodesis is performed via the dorsomedial and plantar medial portals. The portals are interchangeable as the viewing and working portals to ensure throughout preparation of the fusion surfaces. (B) The dorsomedial portal is the viewing portal and the plantar medial portal is the working portal. The articular cartilage of the joint is denuded. The subchondral bone is microfractured with an arthroscopic awl. PMP, plantar medial portal; DMP, dorsomedial portal; PBP, proximal bunion portal; DBP, distal bunion portal; Mi, minitape; MTB, first metatarsal base; MC, medial cuneiform; AA, arthroscopic awl.

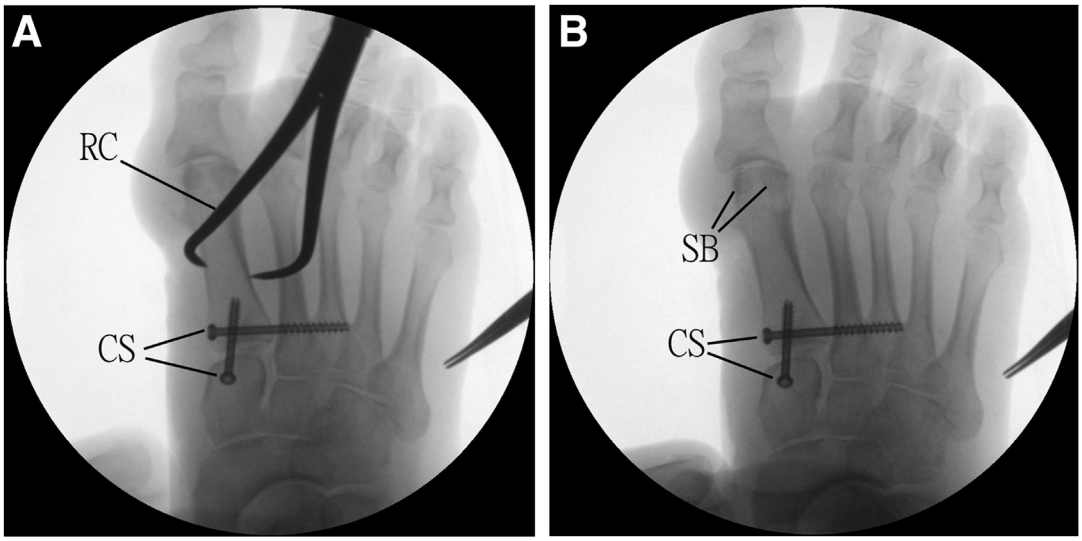

Fig 8. (A) Under fluoroscopic guide, the first intermetatarsal space is closed up by a reduction clamp via the dorsal incision and proximal bunion portal. Two 4 mm cannulated screws (Synthes, West Chester, PA) are inserted: one across the first tarsometatarsal joint and another one across bases of the first, second, and third metatarsals. (B) Final construct shows the hallux valgus deformity is corrected with reduced sesamoid bones.

as suture retriever to bring the minitape (Smith & Nephew) to the lateral edge of the medial sesamoid. The proper position of the minitape can be confirmed arthroscopically with the distal bunion portal as the viewing portal (Fig 5).

Passing Suture Loop Through the Bone Tunnel of the First Metatarsal Neck, the Surrounding Second Metatarsal Neck, the Dorsum of the First Metatarsal Neck, And Back to the Proximal Bunion Portal

A 2 mm bone tunnel is drilled across the first metatarsal neck via the proximal bunion portal. A 16 G angiocath is inserted into the intermetatarsal space via the bone tunnel. A hemostat is inserted via the toe web portal to grasp the angiocath gently. The core needle is withdrawn, and the plastic tube is then firmly grasped and brought to the toe web portal. This serves as a conduit to pass the suture limbs of a PDS suture loop from the proximal bunion portal, through the bone tunnel and intermetatarsal space to the toe web portal. The suture limbs are then brought around the second metatarsal neck to the dorsal incision by an aneurysm needle (GerMedUSA, Garden City Park, NY). The tip of the aneurysm needle "walks" on the bone surface of the second metatarsal before exiting the dorsal incision. This avoids soft tissue entrapment by the suture. The

Table 2. Pearls and Pitfalls

Pearls
Passing the arthroscope and instruments through the intermetatarsal space should be gentle to minimize the risk of injury to the interdigital nerve
The plantar aponeurosis should be pierced at the level of first tarsometatarsal joint to adequate interportal distance for the release.
Release of the lateral capsuloligamentous complex should be started proximal-dorsally and the run distally just dorsal to the lateral sesamoid.
The retrograde knife may need to be shifted a bit laterally to be cleared from the proximal phalanx during release of the most distal part of the capsuloligamentous complex.
Stripping of the cartilage should be at the interface between the cartilage and the subchondral bone
Pitfalls
Failure to release the most distal part of the capsuloligamentous complex will fail to reduce the sesamoid bones.
Incomplete stripping of soft tissue from the bony bunion will hinder effective wrapping of the soft tissue envelop around the first metatarsal head.
It should be cautious to avoid damage of the minitape during drilling the bone tunnel of the first metatarsal neck or application of the reduction clamp.
Excessive plantar flexion of the first metatarsal may cause painful callosity under the first metatarsal head.
Inadequate plantarflexion of the first metatarsal may cause transfer metatarsalgia.

suture limbs are brought back to the proximal bunion portal, dorsal to the first and second metatarsal bones and deep to the extensor tendons, by a hemostat. With the PDS suture loop used as a suture retriever, the minitape is passed through the bone tunnel, wrapped around the second metatarsal neck, and then passed dorsal to the first and second metatarsal and deep to the extensor tendons and then back to the proximal bunion portal (Fig 6). The hallux valgus deformity can be corrected by pulling the minitape.

Arthroscopic Lapidus Arthrodesis

Arthroscopic Lapidus arthrodesis is performed via the dorsomedial and plantar medial portals. The portals are interchangeable as the viewing and working portals to ensure preparation of the fusion surfaces throughout the procedure. The articular cartilage of the joint is stripped from the subchondral bone with an arthroscopic osteotome (Acufex; Smith & Nephew) and removed with a hemostat. The subchondral bone is microfractured with an arthroscopic awl (Acufex) (Fig 7).

Correction of Hallux Valgus Deformity and Insertion of Cannulated Screws

Under fluoroscopic guide, the first intermetatarsal space is closed up by a reduction clamp via the dorsal incision and proximal bunion portal. The hallux valgus deformity usually will be corrected, and the sesamoid bones will be reduced by closing up the intermetatarsal space. Two 4 mm cannulated screws (Synthes, West Chester, PA) are inserted: one across the first tarsometatarsal joint and another across the bases of the first, second, and third metatarsals (Fig 8). The minitape is then tensioned and fixed to the bone tunnel at the first metatarsal neck by a 3.5 mm SwiveLock anchor (Arthrex) (Video 1, Table 2). After surgery, the foot is protected with an ankle-foot-orthosis, and nonweightbearing is advised for 8 weeks.

Discussion

Despite medial shifting of the first metatarsal in hallux valgus, the lateral sesamoid retains its relationship to the second metatarsal in the transverse plane, and release of the intermetatarsal ligament is not necessary.[27] The surgical aim is to put back the first metatarsal over the sesamoids. Incomplete reduction of the sesamoids can be a risk factor for the recurrence of hallux valgus.[28] After adequate endoscopic lateral release, the sesamoids are usually well reduced, and the hallux valgus deformity is well corrected by closing up of the intermetatarsal space, and plication of the medial collateral (metatarsophalangeal) ligament is not necessary.[4-14] In this modified endoscopic distal soft tissue procedure, the intact intermetatarsal ligament, plantar capsule of the first metatarsophalangeal joint (including the sesamoid apparatus), and medial metatarsosesamoid ligament form a soft tissue envelop wrapping around the first metatarsal head by pulling the minitape. The minitape crossing the first and second metatarsal can also augment the intermetatarsal ligament to hold the first metatarsal in the reduced position. Theoretically, preservation of the intermetatarsal ligament in this modified technique may protect the interdigital nerve and reduce the risk of nerve injury during endoscopic lateral release.[14] However, in severe hallux valgus deformity, the lateral flexor hallucis brevis tendon, the flexor hallucis longus tendon, and the interdigital nerve may rotate laterally and can be damaged during lateral release because these structures are proximal to the lateral sesamoid bone and the proximal edge of the intact intermetatarsal ligament (Fig 9). Lateral release, especially the proximal part, should be performed under direct endoscopic visualization.

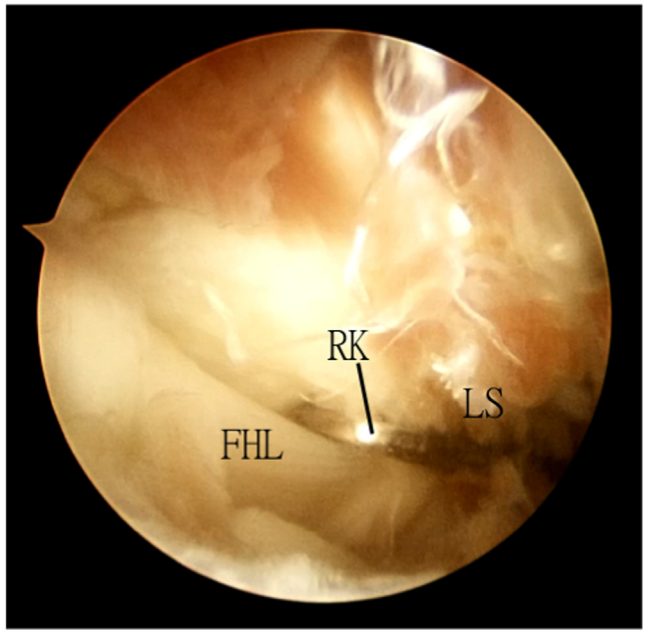

Fig 9. The plantar portal is the viewing portal and the toe web portal is the working portal. In severe hallux valgus deformity, the flexor hallucis longus tendon can be displaced laterally and may be at risk during endoscopic lateral release. LS, lateral sesamoid; RK, retrograde knife; FHL, flexor hallucis longus tendon.

Because the medial metatarsosesamoid ligament rather than the medial collateral (metatarsophalangeal) ligament is reconstructed in this modified technique, it is expected to have less chance of the development of hallux varus deformity or stiffness of the first metatarsophalangeal joint as compared to the original technique.

Lapidus arthrodesis is an established treatment option for severe hallux valgus deformity, especially in patients suffering from instability of the first tarsometatarsal

Table 3. Advantages and Risks

Advantages
Less soft tissue trauma,
Better cosmetic result,
Less wound complications,
Better stabilization of the first metatarsal,
Less stiffness of the first metatarsophalangeal joint,
Less risk of injury to the interdigital nerve,
Less risk of malunion of the first tarsometatarsal arthrodesis and transfer metatarsalgia.
Risks
Inadequate lateral release,
Implant failure,
Recurrence of hallux valgus deformity,
Development of hallux varus deformity,
Interdigital nerve injury,
Injury to the flexor hallucis longus tendon,
Nonunion of the fusion site,
Malunion of the fusion site with transfer metatarsalgia or painful callosity under the first metatarsal head

joint.[21] Compared to the open technique, the arthroscopic Lapidus procedure can better preserve the subchondral bone and have less risk of transfer metatarsalgia.[21]

This minimally invasive technique has the advantage of less soft tissue trauma, better cosmetic result, better stabilization of the first metatarsal, less wound complications, less stiffness of the first metatarsophalangeal joint, and less risk of injury to the interdigital nerve and malunion of the first tarsometatarsal arthrodesis and transfer metatarsalgia. The potential risks of this technique include inadequate lateral release, implant failure, recurrence of hallux valgus deformity, development of hallux varus deformity, interdigital nerve injury, injury to the flexor hallucis longus tendon, nonunion of the fusion site, malunion of the fusion site with transfer metatarsalgia, or painful callosity under the first metatarsal head (Table 3). This is technically demanding and reserved to experienced foot and ankle arthroscopists.

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