A Series of Pure Ankle Dislocations without Associated Fracture: Our Clinical Experience

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Abstract

Background: Pure ankle dislocation without associated fracture is extremely rare, thus the literature almost limited to case reports and small case series. The standardized treatment protocol is in controversy and the studies of mechanism and outcome of the injury are still deficient. We report a series of eight cases of pure tibiotalar dislocations managed with emergency reduction and other heterogenic procedures, hoping to add some material to the published data on this topic and present our clinical experience.

Methods: We retrospectively reviewed the eight cases of isolated ankle dislocations without associated fracture that were treated in our department from 2015 to 2019.

Results: The eight cases were all posteromedial dislocations with six open and two closed. Emergency reduction was performed for all patients followed by average 6 weeks' immobilization with external fixators in five and short leg cast in three. The mean follow-up period was 33 (range, 12 to 61) months. None of the eight patients showed obvious instability though only one patient underwent ligaments repair. The average range of motion (ROM) loss of the ankles was 10 degrees for plantarflexion and 3 degrees for dorsiflexion. Two patients complained of moderate stiffness and three complained of persistent mild pain in whom degenerative change was found. Neurovascular sequela was presented in one patient with numbness. Only one patient developed superficial infection. The average AOFAS score was 90 (range, 78 to 100) points at the final follow-up with five ankles rated as excellent and three rated as good. All of the eight patients returned to their prior daily life and the two closed patients with sports injuries resumed sports activity.

Conclusion: Pure ankle dislocation is a rare ligamentous ankle injury with complicated mechanism. Most of the injuries treated with emergency reduction and thorough debridement followed by a short period of immobilization and functional rehabilitation have good clinical outcomes. Ligaments repair should only be considered in cases of chronic ankle instability after failed conservative treatment.

Introduction

Ankle dislocation without associated fracture (pure ankle dislocation) is a rare injury accounting for only 0.065% of all ankle injuries and 0.46% of all ankle dislocations [1]. D'Anca attributed the rarity to the mechanical efficiency of the mortise and the resistance of the ankle ligaments being greater than that of bone, thus causing ankle dislocation usually accompanied by lateral, medial or posterior malleolar fracture [2]. Due to its rarity, pure ankle dislocations are not well understood with only a limited number of cases being described in the literature. The first documented case with x-ray confirmation was by Péraire in 1913. Since then, several observations have been reported in isolated reports or within small series [2–10]. A systematic review of English literature of 2017 identified 154 cases [1].

Immediate reduction as soon as possible the patient was brought to the emergency department if the risks have been carefully assessed is in agreement with researchers, but the standardized treatment protocol is in controversy and the studies of mechanism and outcome of the injury are still deficient. We describe a series of eight cases of pure tibiotalar dislocation to present our clinical experience and make a review of this topic.

Methods

Patients and data collection

Hospital medical records were searched for ankle dislocations with the ICD-10 code S93.0 between the dates 01/01/2015 and 01/12/2019 in our department. All medical records and radiographic images of the individual patient were studied to confirm the diagnosis of pure ankle dislocations without associated fractures. Eight patients between 2015 and 2019 were enrolled in this study with both pre-reduction and post-reduction radiograph available. The subjects have given informed consent and carried out in accordance with the World Medical Association Declaration of Helsinki.

Details of the patients are listed in Table 1. The mean age of the patients was 38 (18–54) years. The trauma mechanism was traffic accident in 4 patients, falling from a height in 1 patient, sports (basketball) injury in 2 patients and involving in a rotary

cultivator in 1 patient. All eight patients had posteromedial dislocations and six of them were open. The combined injuries were as listed. At the final follow-up, the active range of dorsiflexion and plantarflexion were roughly measured to estimate the range of motion loss compared with the contralateral ankles. The patients were carefully examined for any sign of ankle instability by performing anterior drawer test and inversion stress test. The discomforts of the involved ankles puzzling the patients were gathered such as stiffness and pain. Radiological examination was conducted to evaluate the condition of the injured ankle joints. The American Orthopedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Scale was administered to assess functional status. Depending on the score, results were rated as excellent (90 to 100), good (75 to 89), fair (50 to 74), or poor (less than 50).

Table 1
details of patients with pure ankle dislocation

Patient	Age/ Sex	Laterality / Type (posteromedial)	Cause of injury	Associated injuries	Main Treatment	Follow- up months / AOFAS- AHS / Results	Loss of ROM (degrees)	Instability / Stiffness /Pain / Posttraumatic arthritis / Function
1	19/M	Right / Closed	Basketball	A small compound contusion wounds at lateral aspect of the ankle	i. CR-SLC for 6 weeks ii. Secondary ligaments repair at day 7	36 mo / 98 / Excellent	slightly limited	Returned to pre-injury sports activity level
2	41/M	Right / Open	Motor vehicle accident	i. Skin and soft tissue defect at lateral aspect of the ankle ii. Chondral lesion of tibiotalar facet confirmed by intraoperative exploration	i. External fixation for 6 weeks ii. Repeatedly debridement & VAC for the developed superficial infection iii. Delayed closure & skin graft	61mo / 82 / Good	PF: 15° DF: 5°	i. Superficial infection ii. Mild pain & moderate stiffness iii. X-rays showed degenerative change & osteophyte formation
3	52/F	Left / Open	Motorcycle accident	A 5 cm compound laceration wound at the anterolateral side of the ankle	i. External fixation for 45 days ii. Repair of anterolateral capsule	17 mo / 95 / Excellent	PF: 10° DF: 5°	Slightly instable, functional irrelevant
4	18/M	Right / Closed	Basketball	Nil	CR-SLC for 6weeks	13 mo / 100 / Excellent	Nil	Resume sport activity

CR-SLC: closed reduction & short leg cast immobilization; VAC: vacuum-assisted closure therapy; ORIF: Open reduction internal fixation; AOFAS-AHS: The American Orthopedic Foot & Ankle Society Ankle Hindfoot Scale;

PF: plantarflexion; DF: dorsiflexion; ROM: range of motion.

Patient	Age/ Sex	Laterality / Type (posteromedial)	Cause of injury	Associated injuries	Main Treatment	Follow- up months / AOFAS- AHS / Results	Loss of ROM (degrees)	Instability / Stiffness /Pain / Posttraumatic arthritis / Function
5	39/M	Left / Open	Machine / rotary cultivator	i. A 10 cm compound laceration wound ii. Anterior tibial artery rupture iii. Extensor digitorum longus tendon defect iv. Injury of deep peroneal nerve v. Fracture of high fibula & femoral shaft; inferior tibiofibular syndesmosis intact vi. Chondral lesion of tibiotalar facet	i. External fixation for 50 days ii. Delayed closure & VAC to avoid infection iii. ORIF of compound fractures iv. Repair of the artery, tendons, and capsule v. Rebound air walker assisted rehabilitation	48 mo / 78 / Good	PF: 30° DF: 5°	i. Significant plantarflexion function limitation & moderate stiffness ii. Persistent mild pain with slightly abnormal gait iii. X-rays indicated posttraumatic arthritis iv. Persistent numbness
6	54/F	Left / Open	Motorcycle accident	i. A 3 cm compound laceration wound ii. Craniocerebral injury	i. CR-SLC for 6weeks ii. Repair of anterolateral capsule	45 mo / 95 / Excellent	PF: 5° DF: None	Slight restriction when walking on uneven road
7	47/M	Left / Open	Fall from a height	i. A 5 cm compound laceration wound ii. Injury of superficial peroneal nerve iii. Injury of extensor digitorum longus tendon and extensor retinaculum	i. External fixation for 6 weeks ii. Tendons & retinaculum & capsule repair iii. Rebound air walker assisted rehabilitation	28 mo / 92 / Excellent	PF: 10° DF: 5°	Some difficult on uneven terrain

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8	34/M	Left / Open	Motor vehicle accident	A 8 cm compound wound at the lateral side of the ankle	i. Closed reduction and Steinman pin fixation before transferring to our hospital. ii. Combined external fixation for 6 weeks	16 mo / 82 / Good	PF: 10° DF: 5°	i. Mild pain ii. X-rays showed mild degenerative change
mean	38 ± 13	2 Closed & 6 Open				33mo / 90 ± 8 points	PF: 10° DF: 3°	
CR-SLC: closed reduction & short leg cast immobilization; VAC: vacuum-assisted closure therapy; ORIF: Open reduction internal fixation; AOFAS-AHS: The American Orthopedic Foot & Ankle Society Ankle Hindfoot Scale;								
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Management

The management was heterogenic depending on the circumstances and the attending surgeon's preference. Initial treatment was prompt reduction to regain the normal alignment of foot to minimize the soft tissue compromise and the post-reduction X-rays showed congruent ankle mortise in all patients. The two closed patients underwent closed reduction and short leg cast immobilization for 6 weeks. Besides, one of them adopted non-surgical treatment (Fig. 1) while the other got secondary medial and lateral ligaments repair 7 days after injury because of the patient's strong will to repair the torn ligaments (Fig. 2). Sufficient debridement was performed in the open cases and prophylactic intra-venous antibiotics were used to avoid possible infection. Five of the six open cases were stabilized with external fixators considering the serious compound injuries and to make the wound care easily. The other open patient with small and relatively clean compound wound got immobilization with cast. All the open cases only got repaired the ankle joint capsules if needed though massive ligaments rupture were observed under direct vision in several cases with severe compound wound, especially the lateral ligamentous complex. The ruptured arteries, nerves and tendons were repaired whenever possible, as the patient #5 (Fig. 3) who got his left lower limb involved in a rotary cultivator underwent. Primary closure was performed in four open cases considering the relatively clean laceration wound. The skin and soft tissue defect was managed with skin flap grafting and vacuum-assisted closure therapy (VAC) helped a lot. All the cast and the external fixators were removed around 6 weeks later. Gradually weight bearing and functional rehabilitation training then started up in the following 3 weeks. Rebound air walker was applied to assist early weight bearing walking on the basis of freewill purchase.

Result

The average postoperative follow-up period was 33 (12–61) months during which clinical and radiographic outcome were carefully evaluated. The details of the outcome were as listed in Table 1. Based on the AOFAS scores, all patients had satisfactory result at the final follow-up (five rated as excellent and three rated as good) with a mean score 90 ± 8 (78–100). All the patients but patient #5 who suffered severe compound injury returned to their daily life within 10 weeks later and the two closed patients got injured in basketball games returned to their pre-injury sports levels. At final follow-up, all patients had normal radiographic tibiotalar alignment. All patients showed no obvious instability except one demonstrated slightly mechanical instability which was functional irrelevant and conservative treatment worked. There were two patients complaining of stiffness, and both of them were immobilized with external fixators. The average range of motion (ROM) loss of the involved ankles was 10 degrees for

plantarflexion and 3 degrees for dorsiflexion. There were three patients complaining of persistent mild pain who suffered relatively severer injuries compared with the others. One of them underwent closed reduction and Steinman pins fixation before transferring to our hospital. Chondral lesions were observed intraoperative through the compound wound in the other two patients and the follow-up radiographic examination presented evidence of relatively severer ankle degeneration. Osteophyte formation was apparent in one of them (Patient #2) after 5 years. The same one patient also developed superficial infection which was cured after appropriate treatment. The other patient (Patient #5) who also suffered injury of deep peroneal nerve developed numbness of the medial instep and the sagittal plane movement of the ankle was significantly limited. No other neurovascular deficit was noted after careful examination at final follow-up.

Discussion

Type

Fahey and Murphy [11] classified this injury into five types based on the direction of the dislocation of the talar in relation to the tibia: anterior, posterior, medial, lateral, superior or any combination of these. According to Wight et al. [1], the most common type is posteromedial (46%), followed by medial (20%) and posterior (15%). Distinctly uncommon types are anterior, lateral, and anterolateral, as well as vertical dislocation in which the talus is displaced between the tibial and fibular. Furthermore, the open and closed injury occurrence rate is equal [1, 6]. When it comes to etiology, a review of the literature [4] indicated that road accidents (40%) are prevalent followed by sports trauma (35%), particularly motorcycle accidents (33%) and sports in which jumping is a fundamental component such as volleyball (13%) and basketball (8%) [4]. The diagnosis is made clinically according to the deviation orientation of the foot with respect to the tibia. Radiological examination is required to confirm the diagnosis and exclude the presence of fracture and other latent injury.

Mechanism

The rarity of ankle dislocation without fracture can be attributed to the complicated mechanism of the lesion. Plantarflexion of the ankle, axial loading and inversion violence contribute to posteromedial dislocations which are more common than any other types of dislocations because of the tendency to land with plantarflexion and inversion of the ankle in a fall from a height [4]. The body of the talus is trapezoidal shaped from front to back being wider anteriorly, and thinner posteriorly. The unstable position of the tibiotalar joint is plantarflexion because the narrow part of the talar body lies within the ankle mortise [11], which increases the flexibility of the ankle while decreases the stability of it. The tibiotalar joint have discrete stabilization structures medially and laterally regarding of the malleoli and the collateral ligamentous complexes while the anterior and posterior of the joint have no such structures to reinforce the thin capsule [4, 12], causing the tendency of dislocation on the anteroposterior direction without fracture. In addition, the fibular malleolus is approximately 1cm longer than the tibial one, thus eversion injury is less possible to occur with the bone intact. Furthermore, the deltoid ligament is much stronger than the lateral ligamentous complex, therefore being more protective. Our cases were all posteromedial dislocations but the rotary cultivator machine being the cause (patient #5, Fig. 3) has never been reported in the literature as far as we know.

Fernandes [13], who studied the mechanism of tibiotalar dislocation without fracture on cadaveric ankles, put forward that plantarflexion, axial loading and external rotation resulting in lateral dislocations while external rotation, dorsiflexion and axial loading contributing to superior dislocations. These two types could lead to tibiofibular syndesmotic disruption and therefore instability is expected [4]. Anterior dislocation is usually neglected in view of minimal deformity at the ankle joint [14, 15] of which the mechanism is plantarflexion, anterior force, axial loading [4, 16]. Rotatory dislocation is a typical type of low energy trauma with only a few cases been reported in the literature [2, 3, 15, 17, 18] since pure ankle dislocation is usually the result of high energy trauma such as traffic accident or fall from height [6]. The term rotatory refers to the spin motion of the talus in the frontal plane, which is still restricted in the ankle mortise without anteroposterior displacement [18].

The lesion needs adequate energy to make the talar been stuck by the structures around the mortise and cannot spontaneously return to its normal location when the force is eliminated. In most cases, the dislocation is open by the laceration of soft tissues on the opposite side of the dislocation, which make up the only covering of the malleoli [5]. In addition, neurovascular structures, tendons, and muscles are frequently involved in open dislocations. Aside from violent trauma, it has been postulated that predisposing factors that can contribute to the pathogenesis of this lesion are internal malleolus hypoplasia, lack of coverage of

the talus, ligamentous laxity, weakness of the peroneal muscles, and previous ankle sprains [16, 19]. However, the literature lacked detail to prove these risk factors except for few cases [4, 10, 18]. We found no predisposing factors in our case series and it may attribute to the rarity of the injury.

Treatment Protocol

Regardless of whether the dislocation is open or closed, all the current authors agree of the necessity of an immediate reduction. Recovery of normal range of movement and the lower risk of complications depend on the swiftness of treatment [10]. Delayed repositioning is a negative prognostic factor [18] and repositioning prior to admission in the emergency department is recommended if the risks have been carefully assessed.

Anesthesia before reduction is recommended to permit complete relaxation of the muscles as well as eliminate patient's pain and nervousness. The knee should be flexed to relax the pull of sural triceps on the calcaneus. Longitudinal traction is the first step with one hand hold the hindfoot and the other hold the forefoot. Pronation or supination of the foot is based on whether the shift is medial or lateral [4]. Dorsiflexion of the foot must follow longitudinal traction to allow the talus to return to its normal position in the case of posterior dislocation [4, 20]. To sum up, the reduction direction is just on the contrary of the dislocation direction and thorough knowledge of dislocation orientation and trauma mechanism is necessary for the maneuver.

The literature recommends six- to eight-week immobilization without bearing weight on the concerned extremity [4, 21, 22]. After that, a gradual increase of load and remobilization therapy can be started adapted to the level of pain and swelling, in which proprioception and pronation training playing an important role [23]. The average 6 weeks immobilization length recommended by the literature may be sufficient for ligaments healing and shorter immobilization times may minimize ankle stiffness and ROM loss. Controlled ankle motion (CAM) orthosis may shorten the immobilization period allowing patient to weight bearing walk as tolerated with crutches [24]. We also applied similar orthosis in some cases of ours.

Open injuries usually have a propensity for neurovascular deficits and infections, therefore appropriate treatment should never be postponed [6, 25]. Intra-venous antibiotics should be administrated promptly, and tetanus vaccination for immunization is recommended. Thorough debridement and abundant washout are principle. The application of drainage apparatus and vacuum-assisted closure therapy (VAC) depends on the concrete conditions of the contamination of the wound. External fixation is suitable for the primary stabilization of the affected joint [22, 23, 25, 26] especially in open cases with severe compound wound just as we showed in the 5 cases. However, there were two out of five patients immobilized with external fixators complaining of stiffness. And it is similar to the outcome of Wight [1] with 3/7 patients immobilized with external fixators developed stiffness while 23/134 (17.2%) patients immobilized with cast did. We postulated that external fixation increasing the probability of stiffness compared with short or long leg cast, although the small sample size of the series may make the outcome not be convincing enough or statistically significant. Otherwise, Sayit et al. [26] applied external fixator for primary stabilization and stated that rigid fixation of the ankle at a dorsiflexed position for 6 weeks shortens the disability period and assists in a faster recovery.

Whether To Repair The Ligaments?

Sufficient force in inversion usually results in tear of the anterolateral capsule attachments and the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL), while eversion injury which is rare commonly results in tear of medial capsule attachments and the deltoid ligament [2, 4, 5, 7, 13, 20, 27]. Whether the torn ligaments should be repaired is still in controversy [1, 8, 12].

Most authors recommended that closed reduction followed by immobilization in a cast for six to eight weeks should be performed for closed tibiotalar dislocation if neurovascular involvement was excluded [5, 10, 28]. Toohey [8] reported a good long-term prognosis in closed pure tibiotalar dislocations treated with conservative treatment. Moehring [6] recommended nonoperative treatment for closed dislocation that is stable and have a congruent ankle mortise stating that instability is rare despite massive ligamentous disruption.

More controversy remains with regard to acute ligament repair for cases of open dislocation. Some authors recommended ligaments repair [5–7, 10, 29]. On the contrary, many authors had reported good function in their patients with open dislocation who were treated without ligamentous repair [3, 21, 30, 31]. Wilson et al. [20] believed that operative treatment was unnecessary. Tarantino [21] hold that ligaments repair is unnecessary since they are usually shredded and contused.

The deltoid ligaments

According to Garbuio et al. [5], it is not necessary to repair the medial collateral ligament. They stated that patients with open dislocations who were treated with only repair of the capsule had no difference in joint stability and long-term functional outcome with patients treated conservatively for a closed dislocation. Ucar et al. [31] reported favorable long-term results without ligament and even capsule being repaired in open pure ankle dislocations. Colville et al. [7] and Moehring [6] concur with the viewpoint that it is not necessary to repair the medial collateral ligament. But it is a remarkable fact that all the cases they reported were posteromedial dislocations. According to Moehring [6], the deltoid ligament is always injured but usually retains significant portion of its integrity in posteromedial dislocations, except in gross displacement. As is known, deltoid ligament is the primary stabilizer of the ankle, restricting talar anterolateral rotation in the ankle mortise. The disruption of deltoid ligament producing a marked decrease in the tibiotalar contact area, thus the severity of a medial injury will determine the reduction of ankle stability [32]. Kaneko et al. [29] and Demiralp et al. [33] reported that they performed medial capsule and deltoid ligament restoration in posterolateral cases and gained satisfactory follow-up outcome.

For ankle joint fracture combined with deltoid ligament injury, some authors suggested that repair of the deltoid ligament is unnecessary if the fibula was rigidly fixed and achieved an anatomical reconstitution [34, 35]. Similarly, we can speculate that the theory can be in common use with pure ankle dislocation since the fibula is intact. We concur with the viewpoint that it is not necessary to repair the medial collateral ligaments regarding none of the cases demonstrated obvious instability though only one patient got the torn ligaments repaired.

The lateral ligaments

Elisé [10] and Colville [7] reported a good long-term functional outcome with repairing of the lateral ligaments and capsule in open cases. Moehring [6] recommended repair of the torn lateral ligamentous complex and immobilization with short leg walking cast in the position of 90–110° of dorsiflexion in open posterior/posterior variant cases. Wroble et al. [3] stated that repair of the medial and lateral ligament complexes does not seem to have any effect on long-term outcome. They hold the view that closed reduction is almost invariably accomplished easily, and optimum treatment is immobilization in a short leg cast for 6 weeks with no weight bearing for the first 3 weeks. Previous randomized controlled trials have shown that, for complete lateral ankle ligament ruptures, 2–3 weeks of immobilization in a walking cast or orthosis [36] followed by range of motion exercises provided patients with similar outcomes to ligament repair [37, 38].

The inferior tibiofibular ligaments

In the majority of medial and posteromedial dislocations, the inferior tibiofibular ligaments are spared [6, 7]. However, in the case of superior and lateral pure ankle dislocation, the syndesmosis rupture and instability are expected [20]. Furthermore, regarding the mechanism of superior and lateral dislocations, the inferior tibiofibular syndesmosis and deltoid ligament are inevitably both involved. Burns et al. [39] showed that adding deltoid disruption to syndesmotic injury increased fibular diastasis by 0.7 mm which results a 39% decrease in tibiotalar contact area and a 42% increase in intraarticular pressure. Close [40] and Boden et al. [41] showed similar viewpoint that addition of medial injury to syndesmotic injury increased mortise width significantly. Sagi et al. stated that malreduction of a ruptured ankle syndesmosis is associated with poor clinical outcomes [42]. Therefore, ankle syndesmosis reduction and fixation in superior and lateral dislocations is necessary.

The literature review and recommendation

According to the systematic review of Wight [1], 46% of patients had nonoperative treatment; ligamentous repair was described in 48% (37/77) of open dislocations and 5% (4/76) of closed injuries, in which 27 (66%) repaired lateral ligaments, 10 (24%) medial ligaments and 24 (58%) anterior capsules. Ankle instability was rare (2.6%) (4/154) and not influenced by acute ligament repair.

An open dislocation permits exploration and repair of the ligamentous injuries. However, for open injuries, primary introduction of foreign materials does not seem to be advisable to begin with regarding the risks of infection. Studies have suggested that ankle ligaments repair should only be considered in cases of chronic ankle instability after failed functional rehabilitation [43] and that acute ligaments repair has similar outcomes to non-surgical management [10, 38]. Post-traumatic, clinically relevant instability of the upper ankle joint is rare [4, 21]. Finkemeier et al. [28] recommended non-operative treatment in both open and closed tibiotalar dislocations without fracture and late ligament repair if there is problematic instability. We concur with the viewpoint after reviewing of the literature and analyzing the outcome of cases we treated.

Prognosis

Although some late complications are reported such as stiffness, degenerative changes and joint instability [4, 10, 44], the result remains satisfactory in most cases over a long term, particularly in closed dislocations which are usually treated by nonoperative methods [8, 10, 12, 44]. The functional result for open dislocations is relatively worse and the complication rate is higher [1, 8]. The negative prognostic factors include advanced age, involvement of inferior tibiofibular ligament, presence of vascular injuries, delayed reduction, open dislocation, cutaneous necrosis, and infection [5, 8, 18].

According to Wight [1], Neurovascular compromise prior to reduction occurred in 30 cases (19%), while most of them were resolved after reduction. Particular attention must be paid to neurovascular complication such as dorsal pedal artery, superficial and deep peroneal nerve [4, 44] and neurovascular involvement can seriously compromise the foot's vitality [31] and lead to paralysis or functional deficits. The literature reported some cases of amputation caused by vascular lesions [3, 6, 30]. De-Giorgio et al. [45] presented a case of a 55-year-old man died from anterior and posterior tibial artery tear following a pure anterolateral dislocation of the ankle. Elisé reported residual paresthesia in 25% of his 16 cases [10]. One chronic deep peroneal nerve paresthesia was reported by Rivera [4] as well as the author. Few infections occur in open cases with a rate of 8% [1, 6], and the only superficial infection in our cases was eliminated after appropriate treatment.

The most common complication in the literature is stiffness [1]. We postulate that it is associated with immobilization time and measurement, while rehabilitation exercise plays an important role to reduce its occurrence. Limited ankle range of motion is frequent long-term complication, which is found in 4 out of 8 of Wroble's series [3] with a mean follow-up of 11.5 years postinjury. This often leads to a functionally not significant loss of motion with restriction of mobility in the tibiotalar joint between 0 and 10° [8, 12, 33] and our cases presented similar outcome. The literature reported 10% cases developed arthritis [1]. Narrowed joint space was found in five out of nine cases in Garbuio's study [5] and Elisé S [10] reported four out of 16 cases, with two of which presented an overall narrowing of the joint over 50%. In our cases, patients developed more severe posttraumatic arthritis in whom the intraoperative exploration found tibiotalar facet chondral lesions. Lui [9] hold the view that the chondral lesion is the single most important contributing factor to the development of the posttraumatic ankle degeneration. It is reported that osteochondral lesions of the talus occur in up to 50% of acute ankle fractures and sprains [46] and more severe fracture pattern correlates with more severe chondral lesions [47]. We have reasons to believe that it is the same with ankle dislocations. However, the patients may have joint space narrowing but good outcomes [31].

Preventive measures such as proprioceptive reflex and pronator training seem advisable regarding the injury mechanism [23]. It is possible that high-top shoes and taping of the ankle joint might improve resistance to an inversion injury by limiting the degree of passive inversion and improving the muscle reaction time of the peroneus brevis muscle of unstable ankles [3, 48].

Limitations

The major weaknesses of the present report were the limited follow-up period and the small number of cases. And the series were limited to posteromedial dislocations. However, regarding the limited data on this topic, we believe our case series contributes to the management of this type of injury.

Conclusion

Pure ankle dislocation is a rare injury due to its complicated mechanism. Emergency reduction is principal to minimize neurovascular compromise. Short leg cast immobilization for six weeks is recommended and following functional rehabilitation plays an essential role. As for open cases, thorough debridement is crucial and primary closure is feasible after carefully evaluation. External fixation is an alternative for severe injuries. No matter open or closed the pure ankle dislocation is, primary ligaments repair is not recommended. Chronic ankle instability is rare and secondary supplementary operation is not too late after failed conservative treatment. Therefore, a single primary emergency surgery could be adequate for most of these injuries except cases with relatively dirty open wound and other particular risks. In general, most of the injuries have good clinical outcomes despite the more or less complications.

Abbreviations

CR-SLC

closed reduction & short leg cast immobilization; VAC:vacuum-assisted closure therapy; ORIF:open reduction internal fixation; AOFAS-AHS:The American Orthopedic Foot & Ankle Society Ankle Hindfoot Scale; PF:plantarflexion; DF:dorsiflexion; ROM:range of motion. ATFL:anterior talofibular ligament; CFL:calcaneofibular ligament

Declarations

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None.

Author's contributions

LYX conceived the idea. GTJ and DW collected the data. GTJ performed the literature search and prepared the manuscript. LX and QBQ provided critical appraisal of the manuscript. All authors made critical revisions to the manuscript and approved the final version for submission. ZH supervised all the process.

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Availability of data and materials

Data is property of the authors and can become available by contacting the corresponding author on reasonable request.

Ethics approval and consent to participate

This retrospective study was approved by the relevant Institutional Review Board at the West China Hospital of Sichuan University. The board waived the need for informed consent, as this was a retrospective study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

Radiographs of Patient #4. (A) The Preoperative X-rays confirmed posteromedial dislocation of the right ankle without associated fracture. (B) The final follow-up radiographs at 13 months later showed great state of the involved ankle.

Figure 2

Photographs and radiographs of Patient #1. (A) The image demonstrated the inversion and internal rotation deformity of the right ankle without laceration of the skin. (B) The preoperative X-rays confirmed no associated fracture. (C) Anteroposterior and lateral views of the ankle after immediate reduction and short leg cast immobilization. (D) The medial and lateral ligaments were repaired with suture anchors on day 7 after reduction and the final follow-up radiographs at 2 years later showed a well state of the injured ankle joint.

Figure 3

The X-rays and three-Dimension CT of patient #5. The involved left ankle was lacerated at the anterolateral aspect with the tibiotalar joint exposed and there were compound upper fibular and femoral shaft fracture. The syndesmosis was confirmed intact by coronal section CT. (A) The radiographs demonstrated the posteromedial dislocation of the left ankle without associated fracture (malleolar fracture). (B) The post-reduction X-rays showed congruent ankle mortise and the external fixator immobilization. (C) The final follow-up radiograph presented significant posttraumatic arthritis of the involved ankle.