Using a cervical spine cage to reconstruct malunited fibular fractures

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Abstract

Purpose Anatomical reduction and fixation of unstable ankle fractures is necessary to prevent post-traumatic arthritis. Malunion of the distal fibula in unstable ankle fractures can lead to late degenerative changes of the ankle. Late reconstruction of the ankle can improve its function and postpone the need for ankle fusion or replacement.

Methods We discuss three patients who presented with fibular malunion. All developed medial gutter opening, syndesmotic widening, and lateral shift and/or talar tilt. Surgery involved an anteromedial approach to clean the medial gutter, an anterolateral approach to clean the syndesmotic interval, elongation of the fibula by six to eight millimetres and stabilisation with a cervical spine cage and a locked plate.

Results After one year, all patients had radiologically demonstrated reduction of the talus in the mortise. Improved function was recorded at final follow up. The cage provides several advantages over other fixation methods, including osteoconductive properties, avoiding bone graft donor site morbidity, and the range of sizes allows the surgeon to adjust the amount of elongation.

Conclusions Using spinal cages to treat malunited fibula fractures has several advantages compared to bone graft and good results can be expected.

Introduction

Ankle fracture is one of the most common injuries requiring open reduction and internal fixation [1]. More than age or fracture type, anatomical reduction is the most important

factor for the prognosis and outcome [2]. Malunion of an ankle fracture is associated with poor outcomes and may require reconstruction [3]. Successful reconstruction of a malunion requires accurate assessment, pre-operative planning and special reconstructive techniques [3, 4]. The literature contains little information about reconstruction and clinical outcomes of fibular fracture malunion. Thus, we report our experience with treating malunited fibular fractures to restore ankle joint function.

Patients and methods

Three patients with fibular malunion and functional impairment of the ankle joint were referred to our institution in 2008 and 2009. Patient demographics are shown in Table 1.

Protocol for clinical and radiological assessment

Pre-operative evaluation included documentation of scars, the condition of the soft tissue, neurovascular status of the affected extremity, and range of motion of the ankle joint. Pain scores were documented using a visual analogue scale where 0 was no pain and 10, the worst pain imaginable. Pain scores were also documented at the final follow up. Radiographic investigations included plain radiographs of the ankle joint (AP, mortise and lateral views) and CT scan to estimate rotational malalignment and fibular shortening. Length correction was evaluated using the Shenton line, created by measuring the distance from the lateral process of the talus to the fibular tip. Malrotation was evaluated using a transverse view of the CT scan.

Operative technique

Either general or regional anaesthesia was used. The patient was placed supine on the operating table. Folded sheets

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Table 1 Patient demographics

Characteristic	Patient		
	1	2	3
Gender	Female	Male	Male
Age (years)	45	55	56
Injury	Weber C	Stress fracture of fibula	Weber C + posterior lip of tibia
First treatment	ORIF	Casting	Casting
Reconstruction	Cervical cage + locking plate	Cervical cage + locking plate	Cervical cage + locking plate
Time from injury to reconstruction	3 years	18 months	18 months

were inserted under the pelvis on the operated side. The knee was flexed with a knee support and a tourniquet applied. An antero-medial approach was used to expose the medial gutter, which was cleaned. The lateral malleolus was exposed using a lateral approach. Any existing hardware was removed. The mal-reduced area was exposed. A transverse osteotomy was used to divide the lateral malleolus. The distal segment of the fibula was released and the bone was elongated using a laminar spreader and evaluated with X-ray assistance. A Cervios ChronOS cervical cage (Synthes, West Chester, PA, USA) of the measured size was inserted into the gap created by the osteotomy (Fig. 1). The reduction was assessed radiographically in the operating room, with a corrected talar tilt and Shenton line. The fibula was fixed in place with a locked plate (Figs. 2, 3). The ankle was cast for six weeks in each case. Subsequently, full weight bearing was initiated with the support of an air-cast boot. All patients were prescribed subcutaneous enoxaparin (Sanofi-Adventis, Kuala Lumpur, Malaysia) 40 mg/day for six weeks for thromboprophylaxis.

Bone union was defined as the presence of callus in three planes on AP–lateral radiographs and painless full weight bearing. Patients were seen at two, six and 12 weeks, six months and one year postoperatively.

Fig. 1 Elongation of the fibula with the Cervios ChronOS cage

Results

The mean operative time was 75 min. The mean length restored was seven millimetres (range 6–8 mm). There were no intra-operative or peri-operative complications.

All patients returned to full weight bearing with improvement in symptoms. The mean visual analogue pain score was 7 before surgery and 3 at final follow up. The mean time to radiological union was four months. Full weight bearing was initiated 1.5 months after surgery (Fig. 3). Patients returned to their previous occupations, but only one returned to recreational sports activity.

Discussion

Post-traumatic osteoarthritis of the ankle is a debilitating condition that may occur in younger patients following lateral malleolus fracture [5]. The complexity and congruity of the ankle joint are responsible for its stability. When a tear of the deltoid ligament occurs following an ankle fracture, anatomical reduction of the distal fibular fracture will restore the tibio-talar articulation, thus increasing stability [6]. The fibula and the interosseous

Fig. 2 The elongated fibula is fixated with a locking plate

Fig. 3 **a,b** Malunion of the fibula and talar tilt. **c,d** Elongation of the fibula, fixation with the Cervios ChronOS cage and a locking plate

membrane have a unique role in ankle stability during the stance phase [7]. In cadaveric models of unstable ankle fractures, small fibular displacements were seen to lead to significant increased tibio-talar contact pressures [8].

The rationale in lateral malleolus reconstruction is to achieve a congruent, stable joint in order to avoid post-traumatic ankle arthritis. Several authors have reported their techniques for lateral malleolus reconstruction. Weber and Simpson described lengthening the fibula using a transverse osteotomy and fixation with a plate. No patient in that series received a syndesmotic screw [9]. Yablon and Leach used a transverse osteotomy at the level of the fracture site with autologous tibial graft when the gap exceeded 3 mm. They also used syndesmotic fixation for all patients [10]. Chao et al. described a long oblique osteotomy in the sagittal plane at the level of the prior fracture. After mobilising the

tibiofibular ligaments, the surgeons were able to slide the distal fragment 4–5 mm without difficulty [11]. Weber et al. compared two groups of fibular osteotomies using a standard transverse cut versus a sliding Z-osteotomy in the coronal plane. In their series of six patients, no differences in postoperative outcomes with regard to the type of osteotomy performed were noted [12]. We performed a transverse osteotomy at the site of the fracture. The shape of the osteotomy assisted us in placing the cervical spine cage to achieve the desired elongation.

Different techniques are used to distract the osteotomy to achieve the correct fibular length. Weber and Simpson fixed the distal fragment with a plate and distracted the osteotomy with an AO distractor. Proximal screws were placed when the desired position was achieved [9]. Chu and Wiener used a laminar spreader

or an external fixator when the patient needed concurrent arthroscopy and debridement [13]. We agree that the laminar spreader is very convenient to help achieve and maintain the elongation until the fixation is completed. In our series, no case had a syndesmotic injury; hence, there was no need for syndesmotic opening and reconstruction.

Our technique requires pre-operative planning. We measure the desired distraction length by assessing the Shenton line in the anterior-posterior radiographic view of the ankle. We also assess malrotation with the mortise and lateral radiographic views, and with a CT scan.

Osteotomy fixation is done with a Cervios ChronOS cervical cage (Synthes) and a locking plate. Cervios ChronOS is a system of radiolucent prefilled cages for anterior cervical interbody fusion. Sharp teeth on the cranial and caudal ends of the cage provide initial stability and prevent migration. The appropriate size cage is inserted, which maintains the length of the fibula. In order to achieve compression at the site of the elongation, we use cages one millimetre longer than preoperative measurement. A locked plate secures the reconstruction.

The Cervios ChronOS cervical cage has several advantages. The cage is filled with tricalcium phosphate, which has osteoconductive properties. According to the manufacturer, the central space of the cage is converted to bone six to 18 months after implantation, promoting union of the reconstruction. Bone graft harvesting is not required, resulting in shorter operative times and no donor site morbidity. The Cervios ChronOS cage is manufactured in several sizes and can be prepared based on pre-operative planning. This method avoids bone graft lysis and loosening of the reconstructed position by using a longer implant with sharp teeth on cranial and caudal edges. Finally, the Peek-Optima material facilitates radiographic assessment of fusion. The only disadvantage we note is the high cost of the procedure.

Conclusions

Reconstruction of a malunited fibula with the Cervios ChronOS cage allows easy elongation, maintenance of the reconstruction and stable bony fusion.

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