Charcot Foot: Its Functional Reconstruction and Salvage

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Charcot foot can be defined as a neuroarthropathy leading to foot deformity and often progressive degeneration. It is frequently evidenced by dislocations and fractures, instability and, in some cases, ulceration. When surgery is considered, the traditional approach for most cases has been below-knee amputation, but as greater experience is gained in foot and ankle reconstruction procedures, the salvage of these feet has become a possibility. Charcot foot reconstruction is indicated when the soft tissues are at risk, the foot is unstable or the shape of the foot prevents it fitting into a normal shoe. In most cases, realignment and fusion of the ankle, subtalar, talonavicular, and possibly of other medial column joints is necessary, along with a gastroc slide or Achilles tendon lengthening as excessive plantar flexion is often the initiating force for breakdown in the midfoot, the most commonly affected area.
Resection of plantar prominences may be needed to prevent ulceration from high pressure. This is successful when autofusion has occurred above the prominence; without fusion, resection is generally followed by more significant collapse and recurrence of prominences and/or ulceration.

Key words: *Charcot, diabetes, arthrodesis, bone fragmentation, flatfoot.*

Pie de Charcot: reconstrucción funcional y procedimientos de rescate

El pie de Charcot se puede definir como una neuroartropatía que conduce a una deformidad y, con frecuencia, a una degeneración progresiva de las articulaciones del pie. Se caracteriza por luxaciones, fracturas, inestabilidad y, en algunos casos, ulceraciones. El tratamiento quirúrgico ha consistido tradicionalmente en la amputación por debajo de la rodilla, pero gracias a una mayor experiencia y conocimiento en la cirugía del pie y del tobillo es posible la reconstrucción en muchos casos. Estaría indicada cuando pueden aparecer o existen ulceraciones, si el pie es inestable, o cuando su morfología impide el uso de un calzado normal. En la mayoría de los casos, el realineamiento y la fusión del tobillo, la articulación subastragalina, astragaloescafoidea y posiblemente de otras articulaciones de la columna medial es lo más adecuado. A esto hay que añadir el alargamiento del gemelo o del tendón de Aquiles, ya que una excesiva flexión plantar es con frecuencia la causa que inicia la desestructuración de la parte media del pie, que es el área más afectada.
Puede ser necesaria la resección de las prominencias plantares para prevenir la ulceración por una excesiva presión. Proporciona resultados satisfactorios cuando ha ocurrido una fusión espontánea en la parte dorsal de la prominencia. De lo contrario la resección conduce generalmente a un mayor colapso y a la recidiva de dichas prominencias y/o ulceraciones.

Palabras clave: *Charcot, diabetes, artrodesis, fragmentación ósea, pie plano.*

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Charcot foot is an arthropathy caused by a destructive non-infectious bone lesion associated with fracture or dislocation in patients with peripheral neuropathy. It was described by Jean-Martin Charcot (1868) in patients with tertiary syphilis. Currently it is more frequent in diabetic patients suffering from neuropathies. Charcot described arthropathies associated to tabes dorsalis; his presentation

of "Demonstration of Arthropathic Affections of Locomotor Ataxy". at the Seventh International Medical Congress (1881) established this condition as a distinct pathological entity. W.R. Jordan described the association between neuropathic arthropathy of the foot and ankle, and diabetes mellitus (1936), as well as the factors involved in its pathogenesis: the loss or alteration of sensitive protection, trauma, accumulated mechanical forces and tissue quality.

Approximately 1.5% of patients with diabetes mellitus show evidence of neuropathies on X-rays. In the United States, where the population of diabetics is estimated as 16 million, this small percentage is around 250,000 cases. Charcot's arthropathy can also be seen in patients with myelomeningocele or as a consequence of trauma or surgery in young adults with low lumbar or high sacral motor alterations.

In these cases, the functional motor level is lower than the sensitive level. In addition to these frequent causes, arthropathy may develop in tall people when they are elderly (Figure 1). The excessive length of neuronal axons in patients over 2 meters in height causes progressive degeneration and may give rise to neuropathic foot at 60 or more years of age.

Although most arthropathies are non-progressive and do not cause deformities, Charcot foot with its advanced deformity is a difficult problem both for the patient and for the surgeon. Severe bone fragmentation may cause the loss of ankle dynamic support. The most frequent deformities are seen in Chopart's joint, the longitudinal arc and Lisfranc's joint. This condition causes collapse of the medial column with deviation of the forefoot in abduction and ulcers on the medial side of the foot or beneath the cuboid bone. Gastrocnemius contracture and shortening of the Achilles tendon are very frequent in these feet and may be a significant cause of deformity. The collapse of the medial column is the most frequent cause of neuropathic ulcers and these can slowly lead to a deep infection or even amputation.

A typical patient with peripheral neuropathy is from 45 to 60 years of age and has swelling, erythema and an increase of local temperature near the affected joints; but shows no sign of systemic infection and has little or no pain. The patient continues to walk and this increases the trauma on the damaged area. Ulceration is caused by a combination of lack of skin sensitivity and increase of local pressure on bony prominences. Eighty percent or more of diabetic ulcers are caused by neuropathic feet and are not due to limb vasculopathy; however, sometimes a patient may suffer both conditions.

CLINICAL PRESENTATION

During the early stages of Charcot foot there is inflammation, edema and heat, however, surprisingly, there is little pain. X-ray images of osteopenia associated with ulcers over bony prominences are sometimes mistakenly diagnosed as osteomyelitis or infection.

The apparent areas of osteolysis are caused by hyperemia and not by infection. Frequently patients with chronic symptoms have no pain. The swelling and deformity are due to bone fragmentation and joint dislocation when the hindfoot is in valgus.

During examination it is possible to see overloading of the medial part of the foot, the head of the first metatarsal or the lateral metatarsals. When there is dorsal metatarsal subluxation, the overload may affect the cuboid bone, usually in plantar flexion. The increase of pressure may cause ulcers, mainly beneath the head of the first metatarsal, especially if there is hyperactivity of the *peroneus longus,* and may even cause a deep infection. The valgus position of the hindfoot may cause instability of the medial column and *pes planus* increased by shortening of the Achilles tendon or the gastrocnemius. The deformity known as claw toes is due to the denervation of the intrinsic muscles caused by neuropathy and exposes the metatarsal heads to an overload due to lack of flexion of the MPJs and the fact that the toes must support weight.

PHYSICAL EXAMINATION

Patients must be examined standing on both feet to assess the alignment of the lower limbs and the position of the feet when weightbearing. Varus or valgus of the forefoot or the hindfoot can be examined during the gait ground clearance phase.

The static phase is analyzed from heel contact right up to clearance of the first toe. Ulcer location indicates the positions of bony prominences. The Silfverskiöld[2] test is used to assess if isolated contracture of the soleus causes limitation of ankle dorsiflexion when the knee is in flexion or extension. Greater equinism when the knee is in extension and an increase in dorsiflexion with the knee in flexion indicate that it is the gastrocnemius and not the soleus that is shortened. The person performing the physical exam must ensure that the patient is not trying to make the exam easier or more difficult by means of voluntary muscle contraction. The soft tissues of these patients are abnormal, especially if the control of blood glucose levels is not appropriate and tissue oxygenation is poor. The combination of all these elements together with an increase of pressure on the sole of the foot and the shearing effect of a short Achilles tendon cause skin lesions.

Blocking of ankle dorsiflexion may indicate the existence of a bony stop due to anterior tibial osteophytes or restriction caused by periarticular soft tissues. Frequently the posterior deltoid ligament is involved. Bone fragmentation usually takes place at the level of Lisfranc's joint, and the

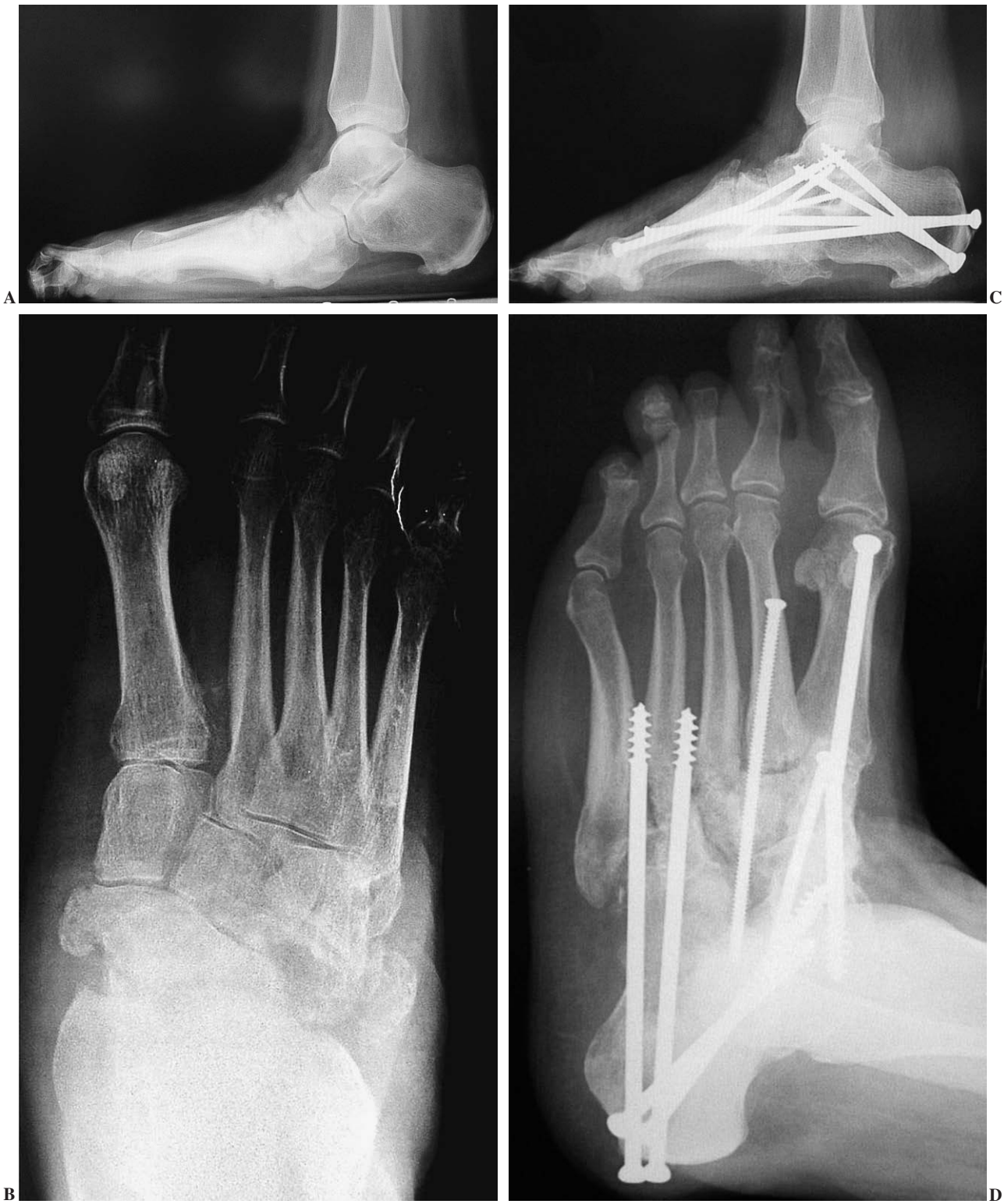

Figure 1. *A: Fifty-eight year old male 2 meters in height with normal glucose levels. When weightbearing it is possible to see in a lateral X-ray the collapse of Lisfranc's and the scaphoid-talar joints with subsidence of the medial arc. B: In an oblique projection it is possible to see the disintegration of Lisfranc's and posterior joints, and also a fracture of the fifth metatarsal. C: In a lateral X-ray it is possible to see an intramedullary nail in the medial column from the head of the first metatarsal to the body of the talus, and anterior and posterior nailing. It is possible to see that the screw in the medial area of the foot is broken, but the patient had no symptoms, and therefore no revision was performed. D: In an oblique X-ray it is possible to see good alignment and sufficient union.*

transverse joints of the tarsus and ankle. The depth of the ulcers must be assessed carefully, since they are easy to treat when they are superficial, but become a serious problem when they reach the bone.

It is also important to examine muscle function and strength, and foot sensitivity. A complete neurological exam must include reflexes and sensitivity assessment using a Semmes-Weinstein filament. This is useful to determine the degree of neuropathic involvement.

Eco-Doppler may be used to perform a vascular examination. However, frequently patients with classical Charcot have excellent vascular function and also normal healing capacity, although bone union may be delayed in patients suffering neuropathy. When assessing appropriate control of glycemia it is important to measure glycosylated hemoglobin (HbA1C).

X-RAY ASSESSMENT

Anteroposterior and lateral X-rays must be taken of both feet and ankles when weightbearing, as also an axial X-ray of the calcaneal. Oblique projections are sometimes useful to see changes in the lateral Lisfranc joint. The Canale projection of the talus neck is the best to assess fragmentation at that level. In some cases a CT is performed to compare the morphology, bone fragmentation and presence of degenerative changes of the affected foot with those of the non-affected foot. A radioisotope study of leucocytes marked with Indium-111 may be useful for identifying the presence of osteomyelitis.

CONSERVATIVE TREATMENT

Most diabetic patients have minor deformities and can be treated conservatively. It is important that patients understand that appropriate glycemia control helps healing, prevents ulcers and also maintains maximum tissue oxygenation. If the shape of the foot adapts to appropriate footwear and is stable, no surgical treatment is necessary, even if collapse is evident on X-rays. However, most of these patients have short gastrocnemius, and lengthening of this muscle has many advantages with very few complications. If the Achilles tendon is lengthened, it is important to avoid excessive lengthening, since this could increase pressure on the heel and cause ulcers to develop on the hindfoot, which are more complicated to treat than those of the forefoot.

Patients with diabetic neuropathy may suffer surgical complications such as infection, wound dehiscence, and non-union, especially when their glycemia levels are not appropriately controlled. However, these patients also have a higher rate of risk during surgery. The first step in their treatment is to protect the affected foot by immobilization with a spica cast or a walker and avoid weightbearing. Normally, in 2 to 3 weeks, the erythema and swelling decrease, although it is recommended that immobilization continue for 8 to 10 weeks to prevent a more pronounced deformity. Once the foot is stabilized, it can be adapted to footwear. It is advisable to use insoles to protect the foot from impacts. Although some patients improve with splints, others continue to suffer pain and significant limitations in their daily activities due to arthritis and deformities. In these cases surgical treatment is indicated.

SURGICAL TREATMENT

Surgery is indicated when soft tissues are affected, the foot is unstable, or it is not possible to adapt it to footwear. Surgery is relatively safe even when there are open ulcers, especially if they are superficial to the plantar fascia and are not associated with osteomyelitis. Foot collapse and other bone deformities can be treated by means of realignment and arthrodesis[3]. The consequence of a combined ankle and hindfoot arthrodesis is significantly affected functionality and it may cause a Chopart joint lesion. This would lead to enlargement of the fused area and greater loss of foot functionality.

Another option to keep in mind would be a transtibial amputation about 18 cm below the knee, not considering this a failure, but for the reestablishment of function after 6 weeks. However, hindfoot and ankle surgery are usually satisfactory in young patients with an appropriate skin status.

If the ankle is in good functioning order, surgery must be performed when there are bone prominences (frequently of the cuboid and cuneiform bones), and the foot is a rocking chair foot or there is joint instability with collapse.

Surgery is also indicated on pressure points or ulcers or areas that could suffer ulcers in the near future and when the shape of the foot does not allow the use of a brace. The orthopedic surgeon must consider prophylactic exostectomy only when the foot is stable and there has been spontaneous fusion above the area of exostosis. Alignment and surgical stabilization require the use of a larger amount of osteosynthesis material than in the case of a non-neuropathic foot, although this may also be associated with a greater number of complications.

Exostectomy must always be performed on stable feet, using a lateral approach and dissecting against the bone, keeping all plantar soft tissues intact. In some cases a small incision may be made over the bone prominence in the medial area of the foot, although this is less advisable. If the hindfoot is not appropriately aligned, osteotomies to achieve medialization or lateralization of the calcaneal can be performed, and the rest of the foot stabilized simultaneously.

The reconstruction of the ankle in Charcot arthropathy, frequently caused by trauma, is indicated when there are ulcers or instability. Rigid fixation is achieved by compression screws and occasionally by using a condyle plate or retrograde intramedullary nail. A retrograde medullary nail is used mainly in cases of ankle or hindfoot fracture or dislocation, although the authors prefer long 6.5 bolt type screws because they provide better rotation control and better reduction.

In case of mid-foot collapse long intramedullary nails may be placed in the MPJ through the first metatarsal up to the talus, thus stabilizing the medial column. Another alternative is retrograde fixation from the posterior part of the talus through the medial column up to the proximal half of the metatarsal. Since the patients suffer from altered sensitivity, opening the joint and retrograde burring to improve alignment does not apparently cause any problems in the MPJ.

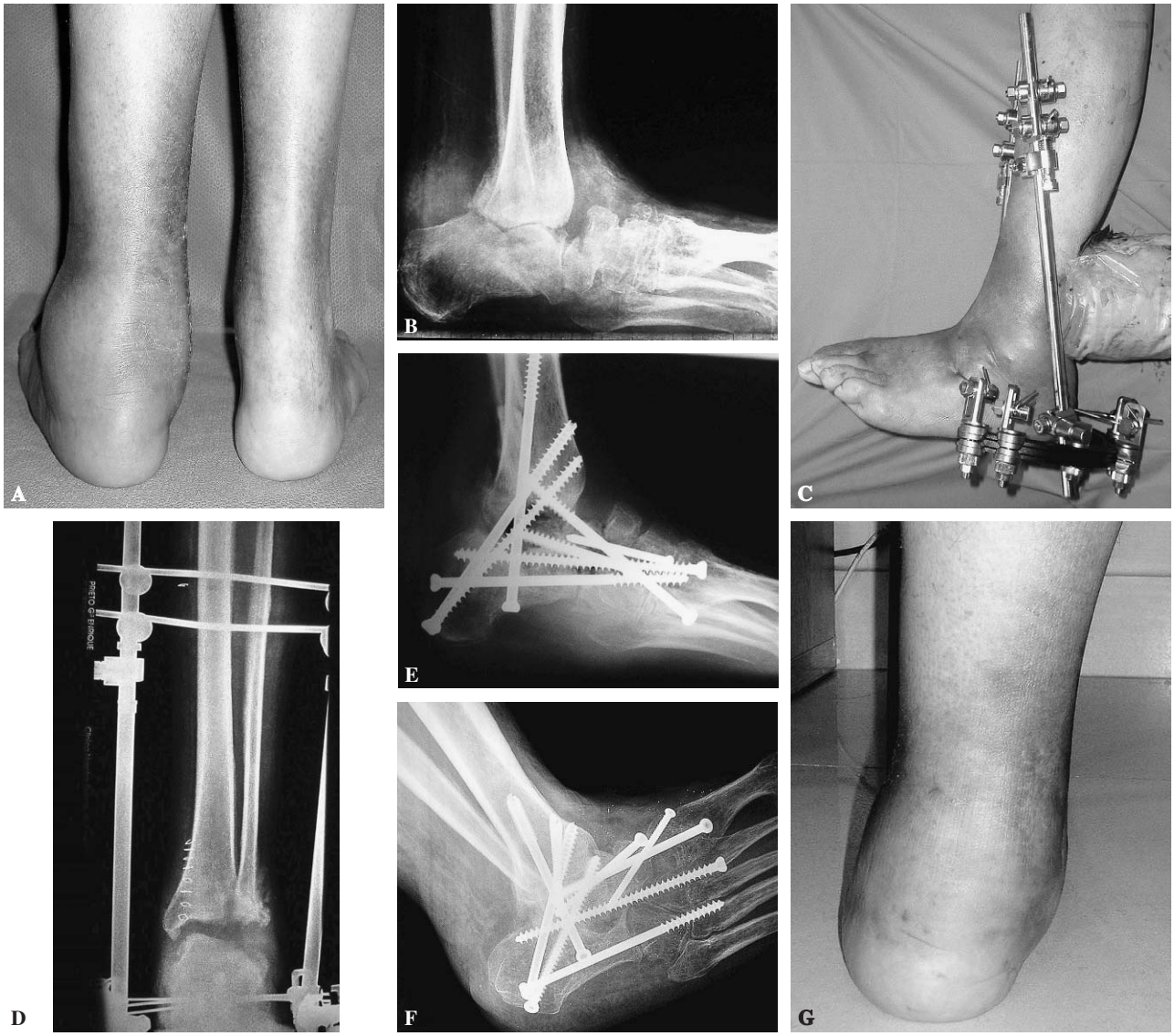

Figure 2. *A: A posterior view of a 46-year-old patient with diabetes mellitus type II and Charcot foot. It is possible to see a significant deformity and swelling of the hindfoot. B: Lateral X-ray projection in which it is possible to see a lateral dislocation of the calcaneal beneath the fibula. The tibia articulates with the body and neck of the partially disintegrated talus and it is possible to see instability of the Chopart joint and collapse of the medial column. C: Lengthening of the Achilles tendon was performed and a hybrid external fixator was used to achieve distraction and reduction of the calcaneal beneath the talus. Pins were placed in the proximal tibia, the posterior tuberosity of the calcaneal and bones of the tarsus. D: An anteroposterior projection of the ankle confirms the reduction of the calcaneal beneath the talus and the disintegration of the fibular malleolus. E: Lateral projection in which it is possible to see a reduction of the unstable ankle and hindfoot, with a double fusion that extends to the Chopart joint, the medial column and the Lisfranc joint. Bank allograft was used to fill in the defects. F: In an oblique projection it is possible to see the extension of the ankle fusion before fibular osteotomy to access said joint. Alignment and stability improve. G: Posterior view of the foot and ankle after reconstruction with a slight residual valgus. The patient now walks without crutches using a double insert and footwear with a rocking chair sole. The patient has returned to his usual work as a bank employee.*

When other treatment options have failed, or when there are complications in patients with insensitive feet, osteomyelitis, non-union or talus destruction, it is advisable to perform amputation below the knee. This is better performed early, before the patient's health deteriorates due to an infection, the drugs used to treat infections or prolonged inactivity. The best amputation technique is the one designed by Ernest Burgess in which a long posterior flap is used to provide muscular cover for the stump[4]. The aim is not only resection of the infected part of the limb, but to restore limb function.

A tibial stump of 18 cm is left to which the prosthesis may be fixed and to achieve an efficient gait. Surgery may be performed under general or spinal anesthesia using a thigh tourniquet and causing a rise in pressure as slight as possible and for the shortest period of time possible so as not to increase the peripheral neuropathy. Surgery begins with a re-assessment of the muscles to determine whether the patient has gastrocnemius contracture or a shortened Achilles tendon. Passive ankle dorsiflexion must be of 5 degrees or more, even with the knee in extension. If foot dorsiflexion with an extended knee is not possible, a Strayer procedure is performed through a medial leg incision at the level of the gastrocnemius-soleus junction, approximately 18 cm above the tip of the tibial malleolus. If the Achilles tendon is lengthened, the method of choice is to use a double percutaneous incision. One anterolateral tenotomy is performed, above the heel, and another medial tenotomy is performed 3 cm from the first one. As has already been mentioned, it is important not to lengthen the tendon excessively.

To reconstruct the medial column, it is useful to perform a medial incision right down to the bone. It is important to take care not to section the insertion of the *tibialis anterior*. If there is instability of the scaphoid-talar joint with or without fragmentation of the talar neck or a scaphoid-cuneiform lesion, the joint is identified proximally and beneath the insertion of the *tibialis anterior* tendon. The cartilage from the medial and central part of the naviculocuneiform joint is excised using curettes and osteotomes and the joint is prepared for fusion perforating the subchondral bone with a 2 mm bit. The lateral portion of the talarcuneiform joint is not included in the arthrodesis.

Joints are reduced and stabilized using several 4 or 6.5 mm bolt type screws. The caliber of these is greater than that of standard 6.5 mm screws. The screws must pass from the scaphoid through the cuneiform bones and from the medial cuneiform to the lateral portion of the scaphoid or in a retrograde manner from the talar-scaphoid bones to the first cuneiform.

As had been mentioned previously, when the joints of the medial column are unstable, a long intramedullary bolt type screw may be used in the medial column. A non-neuropathic foot cannot tolerate so much rigidity, but this does not seem to be a problem in neuropathic patients, if normal ankle mobility is maintained.

Osteotomies are performed to correct fixed deformity, for example, a medializing osteotomy for a heel in valgus. Deterioration or failure of the posterior tibial tendon is treated, when necessary, by transposition of the *digitorum communis* flexor tendon.

Frequently, toe deformities are corrected by means of appropriate balance, for example, transferring the long extensors of the toes to the *peroneus brevis* and lengthening the *peroneus longus* if the first metatarsal suffers excessive plantar flexion with a tendency to form ulcers or corns beneath the head of the first metatarsal.

The correction of tarsometatarsal joint subluxation is performed by means of two longitudinal dorsal incisions, but can be done using the same medial longitudinal incision and another lateral incision.

Joints are opened and prepared for fusion using a small saw and a 2 mm bit to perforate subchondral bone. Fragments and even entire luxated wedges have to be excised so that the foot is appropriately aligned. This procedure shortens the foot, but functional results are good, since the aim is not anatomical reconstruction, but union, alleviation of symptoms, ulcer prevention and adaptation to footwear. Alignment may be achieved using 4 mm cortical (Lisfranc) screws, one placed in an anterograde manner and the second in a retrograde manner, within each tarsometatarsal joint. The longer and stronger the screws used, better are the results.

To reduce the first metatarsal with reference to the second metatarsal a screw is used between the two bases, especially if these are included in the fusion and were previously very separated.

Intraoperative X-rays must be taken simulating weightbearing to ensure that the foot is in the desired position after fixation. To stimulate arthrodesis, bone graft is added in the form of shear strain relief grafting. If there are open wounds it is not appropriate to leave an excess of graft in place since this is devascularized tissue in an area contaminated by bacteria. The graft can be taken from the proximal tibia, beneath the Gerdy tubercle or the bone resected during surgery may be used. To stabilize the fusion of the medial column a tubular plate the third of the length of the shin may be used or even a small DCP plantar plate[5]. In this case, it is necessary to minimize the dissection of soft tissues and bone devascularization. It may be preferable, whenever possible, to use intramedullary nailing or bolt type screws to prevent this.

Finally, a well padded dressing is used for at least two weeks and sometimes three. This is replaced by a slightly tighter spica cast or a weightbearing brace that must be used for 8-10 weeks. At the same time, X-rays are performed to determine whether there is sufficient bone union to allow weightbearing. It may be necessary to wait 3 months before weightbearing and the appropriate moment may be difficult to determine. A decrease of swelling is a better indicator of

union than X-rays. Weightbearing may be increased or the patient can start to walk in a pool. In general, the patient must be immobilized twice as long as a non-neuropathic patient. Finally the patient is fitted with extra deep footwear with rocking chair soles, although occasionally results are so satisfactory that the patient may use normal footwear.

COMPLICATIONS

Wound healing problems are more frequent in patients with Charcot foot, but they are usually not significant. They depend mainly on the persistence of edema, common in this type of patient before surgery, and on postoperative control of glycemia. Soft tissue healing is slower, even with an adequate blood supply. It is necessary to attempt to reduce trauma due to tissue handling during surgery.

Incisions should be made down to the bone level, leaving a thick flap of soft tissue. The wound must be closed under tension using Vicryl or Maxon for the subcutaneous suture. Another procedure that improves results is the practice of admitting the patient to hospital 1 or 2 days before surgery to maintain the foot elevated and decrease inflammation. During the postoperative period, the patient must rest in bed 3 or 4 days, so as not to exert tension on the sutures. In a deformed Charcot foot, the skin on the convex side is contracted and insufficient shortening of the foot may cause excessive skin tension on that side and interfere with wound closure. On the other hand, an excess of skin on the convex side is a minor problem.

In general, whenever bone prominences are resected and appropriate foot alignment is achieved by shortening, skin problems are reduced to a minimum.

Non-union is a possible complication, especially in the first stages of Charcot foot when the bone is soft. Even using the best fixation techniques, 15% of patients develop non-union in one or more joints, some of these will be asymptomatic. The percentage is greater in smokers and patients with bone that does not have a good blood supply. If the screws break it is necessary to perform alignment and arthrodesis revision using additional percutaneous screws and, possibly, a graft (Figure 3). If the screws break and do not cause bone prominence, it is not necessary to perform a new operation. A moderate degree of mal-union can be tolerated, and if it does not cause injuries due to footwear pressure, revision is not necessary. If this is not the case, the patient must be re-operated. Sometimes it is possible to improve the position of the foot by manipulation, withdrawing one or more screws and introducing longer more resistant screws. This avoids re-dissection of the soft tissues and if there is revascularization of the area, healing will take place in a reasonably short period of time.

The use of semi-rigid braces and footwear with rocking chair soles may protect the joints, but the appearance of other complications may make new operations necessary. Many problems after multiple surgeries may make it necessary to perform amputation, sometimes this is the best option. The aim of surgery is to keep the patient mobile and active, and a transtibial amputation allows placement of a stable prosthesis and use of a shoe. If the resulting function is the same, patients generally prefer foot reconstruction to amputation.

CONCLUSIONS

Treatment of neuropathic foot is a challenge for any orthopedic surgeon. Charcot foot has different stages.

Bone fragmentation and collapse are due to lack of sensitivity and pain usually in a diabetic patient, with poorly controlled glycemia. Persistent high glucose levels interfere with hemoglobin oxygenation and may prevent bone union. Therefore, good glycemia control is almost as important as appropriate internal fixation and leads to healing of the reconstructed foot. Without treatment bone prominences may lead to ulcers and infection.

The great majority of patients with Charcot foot may be treated with spica casts, unloading, braces, extra deep footwear and lengthening of the gastrocnemius if this is necessary. Although conservative treatment is satisfactory in most cases, sometimes amputation is the best option for recovery of function. If the procedure of choice is amputation it must be performed early in the course of treatment.

It must be kept in mind that when a foot problem is detected, the first thing to consider is what factors must be corrected in the other foot before this becomes a failure. A very common problem is equinism due to gastrocnemius shortening, which must be treated to prevent Charcot foot on that side. We frequently think that the cause of Charcot foot is an underlying neuropathy in conjunction with abnormal pressure distribution due to a tendency to talipes equinus. It is very important to inform patients so that they know what they must do: maintain an appropriate weight, good glycemia control and use appropriate footwear.

Reconstruction is an alternative to amputation in the treatment of Charcot deformity and makes it possible to avoid uni- or bilateral amputation in selected cases. Surgical reconstruction is indicated to re-establish stability and alignment of the foot and ankle, making it easier to use footwear or braces and preventing ulceration, chronic infection and unnecessary amputation.

Arthrodesis and osteotomies require a greater period of time to achieve union in patients with Charcot foot in comparison with healthy patients. Mal-union and non-union are not infrequent, and probably develop in 10-20% of patients in one or more joints. This percentage increases in smokers and in patients with soft bones. The best treatment is prevention using a careful surgical technique removing all non-viable bone and cartilage, and leaving an appropriate bed for fusion.

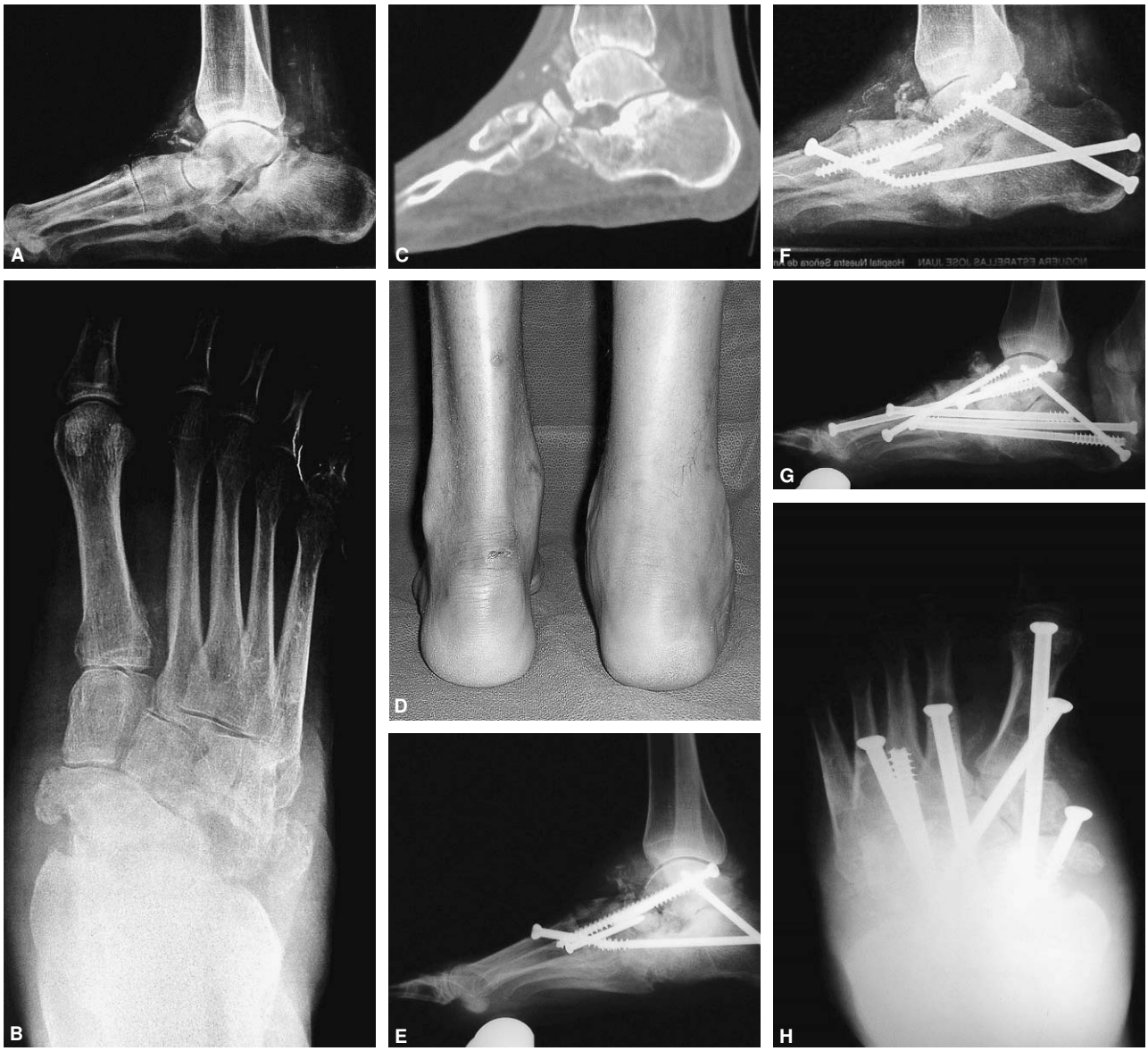

Figure 3. *A: The right foot of a 35-year-old man with diabetes mellitus type I, lateral projection without weightbearing; it is possible to see the collapse of the talar-scaphoid joint with disintegration of the neck and head of the talus. The calcaneal-cuboid subtalar joint are also destroyed. The calcaneal angle is less than 30° and there are many bone fragments surrounding the talus and the ankle joint. B: Anteroposterior projection in which it is possible to see the disintegration of Chopart's joint and foot shortening. C: A transverse section of the scanner shows the fragmentation of the anterior calcaneal tuberosity, with disappearance of the head and neck of the talus. D: Posterior view of the patient, with swelling and deformity of the hindfoot. E: Intraoperative lateral projection simulating weightbearing in which it is possible to see a triple posterior fusion that extends to the medial column. The screw between the first metatarsal and the talus has been introduced in a retrograde manner, first perforating from the first metatarsal towards the talus and afterwards a completely threaded screw is placed from the talus towards the first metatarsal. Alignment has improved. F:Failure six moths later due to breakage of the screw and collapse of Chopart's joint. G: The patient was re-operated, the partially broken screw was removed and long screws were introduced through all the metatarsals except the fifth one. A long cannulated 7.3 mm intramedullary screw was placed from the head of the first metatarsal in the medial column up to the body of the talus. Allograft and autograft were added. H: A dorsoplantar X-ray shows good alignment and each metatarsal, except for the fifth one, is stabilized using a long screw. Union took place and the patient returned to normal life as an actor.*

When there is non-union or mal-union, revision is performed removing broken screws when this is possible, and using grafts and supplementary fixation screws through a minimum number of additional incisions. In this manner the healing of soft tissues which has already taken place is preserved and appropriate alignment and union are obtained. The surgeon is the person who must decide, since in some cases patients are asymptomatic, their activities are not limited and they have no problems with footwear, whether treatment is or not necessary.

A satisfactory result is achieved when ulcers heal, the foot is sufficiently stable and aligned to use footwear, the patients can carry out sufficient activity to keep in shape and help with their glycemia control. A meticulous surgical technique, solid internal fixation, prolonged immobilization, appropriate muscular balance and good control of glycemia are the key factors to prevent amputation and obtain a high rate of success.

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