Amrita Sling Technique: A novel method of foot and ankle stabilization in the deformed Charcot foot

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Abstract: Salvage fusions of the foot and ankle present a unique set of problems to the Podiatric surgeon. Although there have been numerous advances in surgical techniques during the past few years, many of the adaptations involved the use of internal or external fixation devices to stabilize the bony construct while awaiting consolidation. These devices have included screws, plates, intramedullary nails, and external fixators. The use of internal fixation and some forms of external fixation, however, may not be possible or optimal in osteopenia and osteoporosis. In this article, we describe a novel technique of fixation and stabilization of the foot and ankle in deformed Charcot arthropathy. A case report is described using this technique in a patient with osteopenia. In performing the Amrita Sling Technique, we were able to stabilize and firmly fix the hind-foot. The Dexa scan and T-score measurement is discussed in determining which patients will most benefit from this technique.

Key words: Amrita sling technique, Charcot foot, osteoporosis, osteopenia, external fixation, internal fixation.

Introduction

The prevalence of diabetes is increasing rapidly and is likely to reach epidemic proportion in the next decade. There are 246 million diabetic patients in the world today. It is estimated that India had about 31.7 million adult diabetic patients (age group of 20 to 79 years) in the year 2000 and the number is expected to increase to 73 million by 2025. In fact, India is likely to have largest number of diabetic patients in the world. One of the most dreaded complications of diabetes is foot ulcers and gangrene. It is estimated that 15% of all persons with diabetes get foot ulcers and 1% require high-level amputation. The majority of the diabetic foot ulcer patients suffer repeated infections and require hospitalization.

Approximately sixty percent of inpatient admissions of diabetic patients are for foot ulcers and foot infections. More than 50% of non-traumatic amputations are due to diabetic foot gangrene and 85% of these amputations are the result of untreated and/or inadequately treated diabetic foot ulcers. It is therefore estimated that as the prevalence of diabetes increases, a large number of patients in the comparatively younger age group (35 to 45) are likely to suffer from diabetic foot ulcers. Subsequently, many of these patients will require higher-level amputations. This will result in loss of employment and psychological trauma for these patients. The higher the level of amputation, the more energy is required for ambulation with the prosthesis.
About half of amputees suffer a serious lesion on the contralateral limb within two years.\textsuperscript{7} Mortality of patients at 5 years after unilateral major amputation is about 50%\textsuperscript{8}.

When an insensate foot is subjected to even minor trauma or to increased pressure, an ulcer can develop. Ulcers are prone to develop on areas underlying the metatarsal heads, and other undue bony prominences because of the maldistribution of pressure, especially with a Charcot foot and other foot deformities.

In 1868, Jean-Martin Charcot defined a destructive process more appropriately termed neuroarthropathy.\textsuperscript{9,10} Today, Charcot neuroarthropathy has become commonly associated with diabetes because of diabetic neuropathy. The destruction caused by Charcot neuroarthropathy has a complex cause in which joint destruction occurs because of hyperemia, autonomic neuropathy, and inflammation. The combination of hyperemia and trauma produces a chronic inflammatory cycle. At the cellular level, the deformation results in a demineralization of the hydroxyapatite latticework of bone, predisposing the bone to pathologic fracture and dislocation.\textsuperscript{9,11,12}

Salvage fusions of the foot and ankle present a unique set of problems to the foot surgeon. In these cases, the surgeon must frequently deal with extensive scar tissue, bone and soft tissue loss, osteopenic bone, or anatomic changes that have occurred since the primary injury or surgery. Although there have been numerous advances in surgical techniques during the past few years, many of the adaptations involve the use of internal or external fixation devices to stabilize the bony construct while awaiting consolidation.\textsuperscript{9} These devices can include screws, blade plates, intramedullary nails, and external fixators.\textsuperscript{9,13}

The use of internal fixation and some forms of external fixation, however, may not be possible or optimal when there is extensive bone loss, local metabolic dissolution, non-union, osteopenia and osteoporosis.

In some of these difficult cases, the complication and recurrence rate is exceptionally high. Studies done by both Perlman and Thordarson\textsuperscript{15} and Frey, et al.,\textsuperscript{16} had shown an overall 56% complication rate and 55% non-union rate with the use of an external fixator. Charcot arthropathy of the ankle is particularly challenging, because there is often resorption of the talar body, or significant angular deformity with or without instability.\textsuperscript{17,19} In addition, there is a prolonged time for complete stable fusion, which may cause a loosening of fixation as the process evolves. This is especially true once the patient is ambulatory. A resulting deformity may further complicate the clinical scenario.

To provide salvage operations to this group of patients, alternative methods of fixation are necessary to provide stability for a prolonged period of time.\textsuperscript{19-25} Ring fixators may be helpful for such salvage fusions. These ring fixators use tensioned, small-diameter wires to achieve the necessary stability.\textsuperscript{26}

Complications of external fixation are very common, and pin tract infections are the most frequent. Literature reports the rate of pin tract infections to be between 5\%–100\%, with most studies reporting in the range of 10–20\%.\textsuperscript{19,22,26} Moreover, cost is an important factor in a country like India, where less than 50\% of patients are covered by medical insurance.

Our institution, being a major tertiary referral center, receives a large number of Charcot foot cases secondary to diabetes. These are in all stages of the disease and with various foot and ankle deformities, some with marked bony destruction. We see about three new cases of acute Charcot foot every week. Most of the cases taken up for foot and ankle reconstruction are severely osteopenic. In these cases, the compression screws or even threaded Kirschner wires do not hold well, with the chances of re-collapse being very high. To overcome this complication and the problems associated with external fixation, we have developed an alternative technique of foot and ankle stabilization.
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Technique

Lateral and medial incisions, 3 to 5 centimeters long, slightly dorsally placed, are made at the midfoot level. (Fig.1) The nerves and vessels are retracted out of the way. The incisions are then deepened to bone level. After necessary excision of bony prominences, a blunt tipped artery forceps is passed close to the tarsal bone. This can be done from medial to lateral or in the opposite direction. Taking extreme care not to damage the plantar vessels, a space of about five-centimeter width is created. A polypropylene mesh, of 10 x 7 centimeter dimensions, is folded so as to get a double layer of 5-centimeter width. (Fig.2) This is then passed along the passage created in the midfoot area. Next, with a K-wire and driver, a hole is drilled just above the medial and lateral malleolar prominences, not involving the ankle joint. With the help of a thin malleable probe, a number 2 Fiberwire suture is passed through this hole. Using a long, thin Kelly’s forceps, a deep subcutaneous tract is made on either side of the foot and ankle, from the midfoot plantar incision sites up proximally to the Fiberwire on either side of the ankle. Care is taken not to injure the posterior tibial and peroneal arteries. The suture is pulled down subcutaneously to the site of the polypropylene mesh. The two ends of the suture are then tied on to the ends of the mesh, using a round tipped needle. While doing this, proper tension is maintained on the mesh, so that it snugly fits under and around the sides of the midfoot tarsal bones. An assistant holds the foot in the desired neutral position of the foot and ankle, while the suture is being tied on to the mesh. A suction drain is placed just under the mesh. The incision sites are closed in layers with appropriate sutures. The wounds are dressed and a graduated compression bandage is applied. A fiberglass posterior splint is applied with the foot and ankle in the neutral position.

Figure 1 Lateral and medial incisions for the Amrita technique. A 3 to 5 centimeter long, slightly dorsally placed incision is made at the midfoot level. A hole is drilled just above the medial & lateral malleolus with a K wire, through the Tibia & Fibula.

Case report

A 59-year-old male presented with type 2 diabetes mellitus, coronary artery disease and peripheral diabetic neuropathy with chronic renal insufficiency and systemic hypertension. The patient had undergone a left mid foot amputation in August 2008 for gangrene. At time of this surgery, his transcutaneous partial oxygen pressure at the dorsalis pedis level was 52 mm mercury pressure in the supine position.
The ankle brachial index was 1.12. A DEXA scan revealed the patient as having osteopenic foot bones with a T-score of −2.5 and control being +3.

Once the incisions were well healed, he was advised to use plastazote molded diabetic footwear. Over a period of two months, due to the pull of the tendo-Achilles, the calcaneus rotated posteriorly and proximally. This caused the heel pad of fat to shift and the midfoot stump to bear the weight during ambulation. He thus developed ulcerations of the midfoot stump.

The patient then underwent a Boyd’s reconstruction in the first week of January 2009. Through an anterior fish mouth incision, the talus was approached. It was removed and the calcaneus was realigned to proper position so that the heel cushion would be weight bearing. The articular surfaces of the calcaneus and the tibia were prepared, and a calcaneo-tibial arthrodesis done with a titanium rush nail passed through the calcaneus up the tibia.

Since the foot bones were osteopenic, screws could not be used for fixing the rush nail as these would not hold. An ‘Amrita Sling’ was performed to fix the rush nail and also to stabilize the site of the calcaneo-tibial arthrodesis. (Figs. 3-7)

Discussion

External fixators in diabetic patients can frequently cause pin tract infections, which can range between 5% to 100%, with most studies reporting in the range of 10% to 20%.
Figure 5 The suture is pulled down subcutaneously on the medial and lateral aspect of the ankle & foot, to the site of the polypropylene mesh.

Figure 6 The medial & lateral ends of the suture are then tied on to the two ends of the mesh, with proper tension and proper positioning of the ankle and subtalar joints.

These can be the cause of deeper and limb threatening infections like necrotizing fascitis, in these immuno-compromised diabetic patients. Cost is also an important factor in a country like India.

To detect the bone mass density, we use the Dexa Scan. T-score values up to –1 are considered normal, -1 to –2.5 denote osteopenia, and readings below this value denote osteoporotic bones.

The control is a healthy person of the same sex and age. In osteopenic bones of many deformed Charcot foot and ankle patients, internal fixation with compression screws, plates and staples can lead to high rates of re-collapse and further complications. In this scenario, the ‘Amrita Sling Technique’, can help as an alternative modality of internal fixation and stabilization of the deformed foot and ankle in markedly osteoporotic bones seen in Charcot deformities.

In other case reports, we have used a titanium plate below the tarsal bones instead of the polypropylene mesh. However the patient had a thick layer of plantar subcutaneous tissue. In such cases, the patients were thin built with poor plantar subcutaneous fat. Here, the use of a metal plate can be disastrous, as it will be a source of increased plantar pressure, leading to plantar ulcerations. The polypropylene mesh used here is generally used in hernia repair, and is strong and pliable and thus unlikely to be a cause of an increased pressure point. To make it still stronger, we folded it to twice or thrice its normal thickness. Over a period of two to three months, this mesh gets incorporated with the plantar tissues, improving the support to the midfoot and forefoot bones. It does not cause any foreign-body reaction, and is hence safe.
The Fiberwire (Arthrex) is one of the strongest non-absorbable suture materials available. Fiberwire suture is constructed of a multi-stranded long chain polyethylene core with a polyester braided jacket that gives it superior strength, soft feel and abrasion resistance. Suture breakage during knot tying is virtually eliminated. Fiberwire has greater strength than comparably sized standard polyester suture. Studies document significant strength, stiffness, and knot strength with much less elongation. Fiberwire demonstrates biocompatibility characteristics equivalent to standard polyester suture. Superior strength allows tighter loop security during knot tying, increasing knot integrity while reducing the knot profile compared to standard polyester suture.27

Thus, this method of foot and ankle fixation and stabilization should improve the support to the midfoot and forefoot tarsal bones, and also help to stabilize the ankle joint. In selected cases it should be a good alternative to internal and external fixation in deformed, osteopenic Charcot foot and ankle.

Conclusion

This report describes a novel technique of fixation in the osteopenic bones of Charcot foot and ankle deformities requiring surgical stabilization. These types of surgeries have been performed only recently prior to this publication and a follow up report will describe the long-term results of this technique. The real test of the efficacy of the technique can only be determined after the patient is ambulatory for one year or more. Our goal of this report was to generate interest in this new method of fixation and engage in thought sharing with the medical community. We look forward to hearing from our colleagues and reporting on the medium and long term results of the ‘Amrita Sling Technique’.

References

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