Management of Ankle Fractures in Diabetic Patients with Peripheral Neuropathy

A Systematic Review

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By

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INTRODUCTION

Ankle fractures are of the most common injuries presented to orthopedic surgeons. Diabetes mellitus is a common disease with its incidence increasing annually with an ever-aging population. So the incidence of diabetic ankle fractures is increasing annually. Orthopedic surgeons should be aware of the special considerations recommended when managing these cases.

The prevalence of peripheral neuropathy in diabetic patients is high ranging from 19% to 50%. Peripheral neuropathy derives the ankle of its protective sensations making it more prone to injury. This may explain the fact that, the prevalence of diabetic peripheral neuropathy is higher in patients undergoing foot and ankle surgery than the general diabetic population [1].

Peripheral neuropathy also increases the rate of complications of ankle fractures compared to those of the non-complicated diabetics [2]. These complications include infection, loss of fixation, charcot arthropathy and even up to amputation[2]. That's why historically there was a trend to avoid operating upon a diabetic ankle fracture with peripheral neuropathy. However, non-operative management of unstable ankle fracture in this population resulted in a significant higher rate of complications than operative treatment, making the non-operative option questionable [3].

Here the surgeon faces another question; what method of fixation to choose. There are many factors to consider, including age, general condition, fracture pattern and the soft tissue condition[3]. There are many fixation options that include: standard fixation, the more rigid trans-syndesmotic tetracortical fixation, minimally invasive fixation[4], percutaneous closed intramedullary nail, pin and bar external fixation and circular fixation and combined fixation [5].

Peripheral neuropathy also requires special postoperative management of those ankle fractures. It requires longer period of non-weight bearing and the protection with walking cast after weight bearing has begun[6] .

AIM OF THE WORK

This study aims to conduct an objective analysis of the current literature about the management of acute ankle fractures in diabetic patients with peripheral neuropathy. The interventions targeted by this review are non-operative treatment, standard ORIF, rigid ORIF, transarticular fixation, external fixation and combined fixation. We aim to provide evidence based algorithm regarding the management of these fractures by comparison of incidence of inadvertent outcomes with different interventions.

REVIEW OF LITERATURE

Diabetes mellitus

The incidence of diabetes is increasing yearly due to the change in diagnostic criteria [6]. Also the life expectancies of the population have become longer. The prevalence of diabetes has increased 61% from 1990 to 2001 [7]. As a results, numbers of diabetics presented with ankle fractures have increased [8,9]. Complicated diabetes is a strong risk factor for postoperative ankle fracture complications [10]. Complication rate is higher in type 1 diabetes compared to type 2 diabetes. Complication rate is also higher for type 2 insulin dependent diabetes compared to type 2 non-insulin-dependent diabetes [11].

Diabetes mellitus can be diagnosed in four conditions. First, a fasting blood glucose level is ≥126 mg/dL measured on two separate occasions. Second, random blood glucose level is ≥ 200 mg/dL with hyperglycemic symptoms (polyuria, polydipsia, or unexplained weight loss). Third, glucose challenge test is positive with blood glucose levels ≥200 mg/dL. Fourth, elevated hemoglobin A1c > 6.5% [12]. Diabetes end organ damage includes retinopathy, peripheral neuropathy, macro- and micro-angiopathy and nephropathy.

Diabetes and falls

DM increases the incidence of falls in the elderly that reaches 35% in those above 55 years old. DM does not only

increase the incidence of falls but also increase the severity of those falls with higher risk of fracture. This is due to several mechanisms including: decreased sensorimotor function, neuromuscular deficits, foot and body pain, pharmacological complications as hypoglycemia and footwear devices[13].

Diagnosis and assessment

History

Taking a good history is crucial in managing ankle fracture of diabetics. Regarding the history of trauma, the force of injury can tell about the quality of bone. Long standing DM leads to osteoporosis and osteopenia. So, a low energy trauma can lead to a complex fracture pattern [5]. The onset of trauma, either an acute traumatic event or an insidious onset of ankle swelling and erythema suggestive of charcot arthropathy. The patient perception of pain and if he did weight-bear after the traumatic event should also be considered. You should also ask about the pre-injury level of activity and if the patient used any walking aids before the trauma. History should also include insulin treatment, glycemic control, previous ulcers or infection and other symptoms of end organ disease as retinopathy, nephropathy and vasculopathy [5,6]. History of claudication pain can be suggestive of peripheral arterial disease [14]. Smoker patients should be counselled to stop active smoking. Smoking increases the rate of surgical site infection up to 5 folds [15,16].

Examination

Skin condition

Accurate skin examination and documentation of skin condition in the Emergency department is important. Some skin signs indicate urgent intervention and others indicate the necessity of delaying any surgical intervention.

First grossly deformed ankle with skin tenting needs urgent reduction and splinting. Otherwise this area of tenting may be susceptible to necrosis and ulceration turning the fracture into an open fracture. Tense swelling, blisters and loss of skin creases mean that surgery should be delayed till improvement of the skin condition. Any wound or laceration should raise the suspicion of an open fracture which has a further worse prognosis than the closed entity and indicate urgent surgical intervention. [17].

Peripheral neuropathy diagnosis

At time of diabetes mellitus diagnosis, 10% of diabetic patients have peripheral neuropathy. Up to 40% of diabetic patients will have peripheral neuropathy in the first decade after the onset of disease [18,19]. More than 50% of diabetics over the age of sixty have peripheral neuropathy[20]. Up to half of these patients are asymptomatic for peripheral neuropathy making them more susceptible to foot and ankle pathology. Diabetic patients presented for foot and ankle surgery have a higher prevalence of peripheral neuropathy that may reach 80% [21].

Diabetic peripheral neuropathy has multiple subtypes. The subtype related to ankle fractures is the typical diabetic sensorimotor polyneuropathy which is defined as chronic, symmetric, length dependent sensorimotor polyneuropathy developing from metabolic derangements and microvascular alterations [22]. Peripheral neuropathy diagnosis means a higher risk of non-compliance, infection and PAD coexistence [6,23]. It also leads to a higher rate of non-union as the bone and periosteum receive sensory and autonomic innervation that is responsible for release of multiple mediators involved in bone healing [24].

Peripheral neuropathy affects sensory, motor and autonomic functions of peripheral nerves. First, signs of motor affection includes clawing of toes due to intrinsic muscle atrophy. Second, autonomic dysfunction may be manifested as dry, cracking, hyperemic skin due to alterations in the microcirculation. Third, sensory affection is manifested as inability to feel fine touch, vibration or pinprick [6]. Sensory examination will be explained in detail as it represents the mainstay for screening for peripheral neuropathy.

Touching the tip of the foot and asking the patient if they feel the touch is not adequate for diagnosis of peripheral neuropathy [25]. The gold standard for diagnosing peripheral neuropathy is nerve conduction studies [5,6].

A common and accepted way to screen for peripheral neuropathy is to use 5.07 Semmes-Weinstein monofilament. This method has 91% sensitivity and 86% specificity [26]. The monofilament should be applied perpendicular to skin until it buckles for 1 second. It is applied in four areas (the planter surface of the first, third and fifth metatarsals and big toe). The patient should be visually blinded from testing. He should give a verbal cue when sensing the filament. Peripheral neuropathy is diagnosed if the patient could not sense one or more of the filaments in the ipsilateral foot [27].

The use of tuning fork for loss of vibration perception is less sensitive than the 5.07 Semmes-Weinstein monofilament [28].

A valid non-invasive screening tool for peripheral neuropathy is the Michigan Neuropathy Screening Index (MNSI). This index depends on five items; Semmes-Weinstein monofilament, vibration testing with a 128-Hz tuning fork, Achilles reflex, ulceration and neuropathic deformity. Peripheral neuropathy is defined as MNSI score >2.0 [21,29] The routine use of MNSI in diabetics presented with ankle fractures is recommended as peripheral neuropathy diagnosis will affect the decision making in these patients [3].

Table 1: Showing how to calculate the 5 items of MNSI. Maximum score per foot is 5. The combined maximum score of both feet is 10. Peripheral neuropathy is defined as MNSI score >2.0.

Item	score
1. Four planter sites (the first and fifth metatarsal head, planter hallux and heal) touch with 5.07 Semmes-Weinstein monofilament with eyes closed	0 for each foot : if the patient could sense all the four sites 0.5 for each foot: if the patient was unable to sense the monofilament in 1 of the 4 sites 1.0 for each foot: if the patient was unable to sense the monofilament in 2 or more of the 4 sites
2. Vibratory sensation with the 128-Hz tuning fork at the dorsal hallux	0 for each foot: if the patient could feel the vibration consistent with the duration the examiner felt while holding the tuning fork 0.5 for each foot: if the patient could initially feel the vibration but was unable to sense it after 5 seconds of dampening 1.0 for each foot: if the patient was unable to sense the tuning fork at all or noted absence within five seconds
3. Achilles reflexes	0 for each foot: intact reflex without reinforcement 0.5 for each foot: intact reflex with enforcement 1.0 for each foot: absent reflex
4. Foot ulcer	0 for each foot: no ulcer 1 for each foot: ulcer
5. Neuropathic deformity (claw toe or charcot neuopathy) evaluated clinically and radiographically	0 for each foot: no deformity 1 for each foot: deformity