The role of the tibialis anterior muscle in minimally invasive plate osteosynthesis of tibial fractures – an anatomic study.

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Introduction

Percutaneous fixation of tibial fractures, using a less invasive stabilisation system (Less Invasive Stabilisation System; Synthes GmbH, Glutz Blotzheim-Str. 1-3, 4500 Solothurn, Switzerland), is becoming increasingly common (1,2). We examined the variation in the origin of the tibialis anterior muscle from the lateral aspect of the tibial shaft and interosseous membrane as well as the variation in the morphology of musculotendinous junction in relation to the medial malleolus. In the percutaneous technique for tibial osteosynthesis the plate is inserted between the muscle and periosteum. This protects the neurovascular bundle as it lies within the muscle belly (3,4). Shorter muscle bellies protect the neurovascular bundle for a smaller portion of their proximal course in

Material and methods

Forty cadaveric lower leg specimens (20 left and 20 right, unpaired), prepared by the Thiel method, were used in our study (5). The ages ranged from 55 – 83 years (mean 71.5 years) old. Twenty two specimens were from male cadavers and 18 from female ones. None of the specimens had had previous surgery or suffered any injuries. The absence of previous bony injuries was confirmed with radiographs. The length of the tibia was measured as the distance between the centre of the medial joint line at the knee and the tip of the medial malleolus (6). A mathematical method employing stature regression formulae correlates tibial length with body height.

Following the removal of the skin and superficial fascia the anterior osteofascial compartment of the lower leg was identified. The deep fascia was then removed. The tibialis anterior and extensor hallucis longus muscles were then dissected out. The distal limit of the tibialis anterior muscle origin was identified with a magnifying glass. This was then marked with a needle and the vertical distance to the level of the medial malleolus was measured with a sliding gauge. The distal tip of the transition zone was identified with a magnifying glass and taken as the musculotendinous junction and its vertical distance to the level of the medial malleolus was measured with a sliding gauge. The data were recorded and subjected to statistical analysis using Microsoft Excel® 2003 (Microsoft Headquarter, Redmond, Washington, United States).

Results

The length of the tibiae ranged from 29.5 to 45 cm, with a mean of 36.5 cm and standard deviation of 3.1 cm. The distal limit of the muscle origin was 5.9 – 20.5 cm (mean 12.1 cm, ± 3.3) from the tip of the medial malleolus. In 7 specimens these distal fibres were attached to the interosseous membrane and in 33 to the lateral tibial cortex. The variation of the muscle origin (lateral tibial cortex and interosseous membrane) although interesting to demonstrate, does not seem to be clinically relevant here. The distance between the musculotendinous junction and the medial malleolus ranged from 1.4 – 10.8 cm (mean 6.1, ± 1.9). The muscle origin extends 15.3 – 31.8 cm (mean 24.4 cm ± 4.1) distal to the level of the joint line at the knee (figure 1). Student-t test was used for statistical analysis of these non-parametric data. P-va-
lues below 0.05 were regarded as statistically not significant. There was no statistical correlation between tibial length and muscle morphology (musculotendinous junction: p-value=0.09, distal fibres of muscle origin p-value=0.39).

Discussion

The use of minimally invasive techniques with angular stable plates is fast becoming part of the standard armamentarium of the trauma surgeon with ever increasing indications. These plates are inserted percutaneously between the tibialis anterior muscle and the periosteum, and thus the neurovascular bundle is protected by the muscle belly. The Tibilialis anterior is situated on the lateral side of the tibia; it is thick and fleshy above, tendinous below. It arises from the lateral condyle and upper half or two-thirds of the lateral surface of the body of the tibia; from the adjoining part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septum between it and the Extensor digitorum longus. The fibres run vertically downward, and end in a tendon, which is apparent on the anterior surface of the muscle at the lower third of the leg. After passing through the most medial compartments of the transverse and cruciate crural ligaments, it is inserted into the medial and under surface of the first cuneiform bone, and the base of the first metatarsal bone. This muscle overlaps the anterior tibial vessels and deep peroneal nerve in the upper part of the leg (figure 2) (6).

This study demonstrates the variable morphology of the tibialis anterior muscle. Hence the neurovascular bundle is protected in the anterior compartment through a variable portion of its proximal course. The muscle origin may extend distally on average 24.4 cm from the level of the knee joint. Tibial LISS plates vary in length from 15.6 cm (5 holes) to 31.6 cm (13 holes). Longer plates allow for more distal fixation but this is countered by the increased risk of damage to the neurovascular structures from positioning of the plate and insertion of the distal screws. The 11 hole tibial LISS plate is 27.6 cm long, which is beyond the average length of the tibialis anterior muscle belly described in our study.

We advocate an open technique for the insertion of 11 and 13 holes LISS plates in order to position the implant over the periosteum under direct vision. This may be achieved through extension of the distal incision in order to ensure the apposition of the plate to the bone and to avoid interposition of the neurovascular bundle beneath the plate.

References: