DONOR SITE MORBIDITY FOLLOWING RESECTION OF VASCULARIZED FREE FIBULAR GRAFT FOR SKELETAL RECONSTRUCTION

BY

DR MUHD RUZAIMI BIN ABD RAZAK
MD,(UKM)

UNIVERSITI SAINS MALAYSIA

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ABSTRACT

Tajuk :

MORBIDITI KAWASAN PENDERMA SELEPAS PENGAMBILAN GRAFT TULANG FIBULA UNTUK REKONSTRAKSI TULANG RANGKA

Pengenalan: Fibula graft adalah satu teknik untuk mengembalikan keutuhan tulang rangka akibat kecacatan tulang. Walaupun teknik ini amat berguna, namun banyak laporan berkaitan masalah di kawasan dimana tulang ini diambil terutamanya berkaitan sendi pergelangan kaki.

Objektif: Tujuan kajian ini dijalankan adalah untuk mengukur secara objektif masalah di kawasan penderma selepas pengambilan graft tulang fibula dan mengkaji perubahan radiologi pada pandangan mortis sendi pergelangan kaki. Juga untuk mengetahui panjang hujung bawah tulang fibula yang perlu di tinggalkan untuk meminimakan masalah di kawasan penderma.

Cara kajian: Kajian lintas-lintang telah dilakukan kepada pesakit yang telah dibuat pembedahan pengambilan tulang fibula graft. Dua puluh orang pesakit yang telah diambil sebelah graft tulang fibula dan sebelah lagi kaki normal dikenalpasti. Evaluasi telah dilakukan pada pesakit antara 15 hingga 96 bulan selepas pembedahan dengan purata 45.25 bulan. Sistem pemarkahan pergelangan kaki Mazur's digunakan untuk objektifkan analisis subjektif symptom dan pemeriksaan klinikal. Kajian radiologi termasuk pandangan mortis sendi pergelangan kaki semasa berdiri dan semasa baring dilakukan.

Kajian keatas jarak antara hujung melleolus luar berbanding hujung melleolus dalam dijalankan. Darjah kecondongan baki bawah tulang fibula sendi kaki juga diukur.

Keputusan: Sistem pemarkahan sendi pergelangan kaki Mazur's menunjukkan 15(75%) pesakit cemerlang kiraan mata (kiraan mata 90 keatas) dan 5(15%) pesakit mendapat kiraan mata yang bagus (kiraan mata dari 79 hingga 89). Pada radiologi pandangan mortis semasa berdiri terdapat signifikan pergerakan ke atas pada baki bawah tulang fibula dengan purata 7.45 milimeter. Terdapat linear korelasi diantara pengiraan mata Mazur's dan panjang baki tulang fibula sebelah bawah.

Kesimpulan: Sistem pemarkahan sendi pergelangan kaki Mazur's adalah sistem yang bagus untuk objektifkan analisis subjektif masalah bahagian penderma selepas pengambilan tulang fibula graft.. Limitasi pada fungsi aktiviti pesakit selepas pengambilan tulang fibula graft adalah disebabkan oleh sakit, ketakstabilan dan kelemahan otot tetapi ini tidak cukup untuk tidak melakukan pengambilan tulang fibula. Terdapat signifikan perubahan radiology pada pandangan mortis pergelangan kaki semasa berdiri selepas pengambilan tulang fibula terutama pergerakan keatas baki bawah tulang fibula Terdapat korelasi linear yang signifikan diantara pengiraan mata sendi pergelangan kaki Mazur's dan baki tulang fibula bawah, minima baki tulang fibula bawah yang perlu ditinggalkan adalah sekurang-kurangnya 7 sentimeter berkait dengan Sistem pemarkahan sendi pergelangan kaki Mazur's lebih dari 90%.

ABSTRACT

Title :

DONOR SITE MORBIDITY FOLLOWING RESECTION OF VASCULARIZED FREE FIBULAR GRAFT FOR SKELETAL RECONSTRUCTION

Introduction : Fibular graft is a useful technique to restore skeletal integrity of bony defects. Despite the benefit of this procedure, there are some reported problems associated with donor site particularly with regards to ankle joint.

Objective : The purpose of this study to objectively measure the morbidity to the ankle joint after fibular graft harvest and to study the significant radiological changes in ankle joint. Also to know the residual distal length of the fibula that should be maintain to minimize the donor site morbidity.

Methodology : A cross-section study was performed on patients who had undergone autogenous vascularized fibular graft harvest. Twenty patient who had undergone unilateral fibula harvest with normal contralateral ankle were identified. Patients were evaluated within 15 to 96 months post operation with average of 45.25 month. Mazur's ankle score was used to analyses the subjective symptom and sign. Radiological assessments to both ankle which include mortice views on non weight bearing and weight bearing were performed. The distance of the tips of lateral melleolus and the tips of medial melleolus were calculated and the tilting angle of the residual distal fibula were measured.

Result :_Mazur's ankle score shows 15(75%) patients has excellence outcome (scoring mark 90 and above) and 5(15%) patients had good outcome (scoring mark from 79 to 89), none of them had fair or poor results. In weight bearing mortise view of ankle x-ray, there is significant proximal migration of residual distal fibula with average 7.45 mm. The analysis for correlation between Mazur's ankle score and residual distal length of fibula shows a significant positive linear correlation with a good correlation.

Conclusion :_Mazur's ankle score are good objective scoring system for subjective assessment of donor site following vascularized fibular grafting. Limitation of functional activity to the ipsilateral ankle following fibular harvest is not considered significant enough to discourage transplantation of large segment of fibula. There is significant radiological changes in mortise view of ankle x-ray post fibular harvest especially proximal migration of residual distal fibula on weight bearing. The significant linear correlation between Mazur's ankle score with residual distal length of fibula was observed. The minimum of 7 cm residual distal fibular correlate with Mazur's ankle score more than 90%.

1.0 INTRODUCTION

The use of free fibular grafts has been well reported for the treatment of various conditions. These include reconstruction of bony defects and nonunions, osteomyelitis, bone loss after resection of tumors, spinal surgery fusions, and congenital pseudarthrosis of the tibia.

Fibular graft has become as a established method for the reconstruction of large bone defects since its first description by Taylor (1975). In 1993, Chen and Yan (1983) pioneered the use of this graft for the reconstruction of radius and tibia in post traumatic defect. The fibula graft was developed originally for extremity reconstruction. It is now used in various clinical applications.

There are only limited number of centre that have a capability in performing this procedure. Hospital Universiti Sains Malaysia Kubang Kerian, Kelantan is one of the centre that known to have the capability and act as tertiary referral for musculoskeletal tumor and maxillofacial surgery.

A fibular is a vertical bone and has a excellangt strength for reconstruction. It also has a potential for remodeling after years of loading. Several studies looked specifically the resultant donor site morbidity following free fibular harvest (Anderson AF 1991, Anthony JP 1995, Bobovic S 2000, Goodacre TEE 1990, Lee EH 2005, Shpitzer T 1997, Youdas JW 1988). The resultant donor site morbidity has occasionally been referred to as insignificant. However, several reports have found significant functional changes following partial fibulectomy related to the amount of harvested length and distal residual length. This include decreased range of motion and strength at the knee and ankle, gait alteration, contracture, stiffness and weakness of the great toe. However there is no consensus with regard to quantitative measurement.

Previous biomechanical cadaveric studies have suggested that the length of the residual portion of the distal part of the fibula has an important effect on stability of the ankle (Lorenzo L 2003). The study did not address the effects of muscle forces on the ankle, nor does it simulate the varying loads and ankle positions seen during normal activity. No previous study has quantified the amount of distal fibular bone that is needed to minimize the donor site morbidity.

The purpose of this study is to objectively measure the morbidity of ankle joint, observe the changes in ankle mortise view ankle x-ray and assess the residual distal length of the fibula that should be maintain to minimize the donor site morbidity.

2.0 LITERATURE REVIEW

2.1 RELEVANT ANATOMY

2.1.1 ANKLE JOINT

Ankle joint is a uniaxial, modified-hinge joint formed by the talus, the medial malleolus of the tibia, and the lateral malleolus of the fibula. Specifically, the concave distal articular facet of the tibia articulates with the convex superior articular surface of the talus. The medial malleolus articulates with the medial aspect of the talus, whereas the lateral malleolus articulates with the lateral aspect of the talus. The stability of the ankle mortise is enhanced because the dome-shaped body of the talus fits snugly into the slightly concave tibial undersurface (Goss CM, 1973).

The relation of the tibia, fibula, and talus is maintained by an articular capsule and 3 groups of ligaments (medial, lateral, and syndesmosis). The articular capsule surrounds the joint and is attached to the borders of the articular surfaces of the malleoli proximally and to the distal articular surface of the talus distally. The anterior aspect of the capsule is broad, thin, and membranous, whereas the posterior component of the capsule is very thin and consists mostly of transverse fibers. The lateral aspect of the capsule is slightly thickened (Goss CM, 1973).

The deltoid ligament is a strong, flat, and triangularly shaped ligament on the medial aspect of the ankle. This ligament consists of 4 bands: the anterior tibiotalar, the posterior tibiotalar, the tibiocalcaneal, and the tibionavicular. The deltoid ligament is considered the strongest of the ankle ligaments (Close JR, 1956) and, especially during plantar flexion, functions to prevent excessive eversion at the subtalar joint. The deltoid, particularly its anterior portions, also resists talar external rotation. The lateral malleolus extends further distally than does the medial malleolus and, as a result, provides a bony limitation against excessive eversion.

Three lateral ligaments aid in preventing excessive inversion at the subtalar joint. The anterior talofibular ligament, the posterior talofibular ligament, and the calcaneofibular ligament make up the lateral collateral ligaments of the ankle (Pick TD, 1977). The anterior talofibular ligament limits anterior displacement and medial shifting of the talus and posterior displacement and lateral rotation of the tibia and fibula, respectively, primarily in plantar flexion. This ligament also helps to prevent lateral talar tilt. The posterior talofibular ligament braces the talus posteriorly and helps to limit talar external rotation (or internal rotation of the tibia and fibula). The calcaneofibular ligament functions to prevent lateral talar tilt, principally when the ankle is in a neutral amount of plantar flexion and dorsiflexion.

Burks et al. (1994) studied the anatomy of the ankle ligaments in a cadaver dissection involving 39 specimens. He noted that the anterior talofibular ligament had an average length of 24.8mm and directed at an average of 44.8 degree medially from the fibula to the talus. The centre of the ligament bulk was located at average of 10.1 mm proximal to the tip of fibula. This was measured along the long axis of the fibula. Its insertion was at an average of 18.1 mm proximal to the subtalar joint of the talus. Calcaneofibula ligament had an average measurement of 5.3 mm wide, 35.8 mm long and formed an angle of 133 degree with the fibula when the foot was in plantigrade.

The bony and ligamentous arrangement of the ankle joint provides it with considerably more stability than other diarthrodial joints, such as the knee or shoulder. Depending on the position and the loads placed on the joint, the bones and ligaments alternate as primary and secondary stabilizers. Weight bearing and axial loading have been reported to increase ankle bony stability. When dorsiflexed, the ankle is thought to be in the most stable position, sometimes termed close packed, since this is the position of the most bony contact. In this position, most of the mortise is occupied by the talus, and contact is maximal between the involved articulating surfaces.

2.1.2 TIBIOFIBULAR JOINT

This articulation of the fibula with the tibia can be subdivided further into 3 regions: the proximal tibiofibular joint, the interosseous membrane, and the distal tibiofibular joint. The proximal tibiofibular joint is a joint that is held in place by the anterior superior tibiofibular and posterior superior tibiofibular ligaments. This articulation helps to maintain proximal integrity between the tibia and fibula.

The interosseous membrane holds the fibula and tibia together. This membrane also stabilizes any posterolateral bowing of the fibula that may occur with weight bearing (Thomas, 1993). It also provides additional attachment site for muscles and may have some load bearing function. This membrane is a thick osseofascial structure extending from the tibial periosteum to the fibula, nearly the entire length between the 2 bones. Anteriorly, the fibers are parallel and run obliquely downward from the tibial interosseous ridge at approximately a 15° to 20° angle. Posteriorly, the fibers are closer to vertical as they run from the tibia to the fibula.

Skraba and Greenwald (1984) investigated the role of the interosseous membrane in stress transmission to the fibula. The loads experienced in normal gait were reproduced using 3 cadaver legs fitted with strain gauges. The interosseous membrane was found to play an important role in transfer of forces to the fibula. After the membrane was incised, strains recorded in the fibula decreased to approximately 0. These results suggest that an intact interosseous membrane keeps the fibula active during weight bearing and that this structure plays an active role in normal tibiofibular function.

Thomas et al (1993) investigated the roles of the fibula and interosseous membrane on compressive load sharing in the lower extremity. Twelve fresh-frozen cadaver lower extremities were evaluated intact, after interosseous membrane sectioning, and after partial fibula excision. The specimens were also tested in different ankle and subtalar positions. Thomas et al (1984) in contrast to Skraba and Greenwald (1993) found that fibular strain was not reduced to 0 after sectioning of the interosseous membrane, indicating that loads are transmitted at the proximal and distal tibiofibular articulations.

The ligaments of the syndesmosis form a complex articulation that maintains the fibula closely approximated in the fibular notch. Interosseous membrane run between the tibia and fibula at the level of the proximal tibiofibular joint. On the other hand the interosseous ligament is an inferior extension of interosseous membrane and is a key transverse stabilizer of tibiofibular articulation.

The inferior tibiofibular joint is defined as a syndesmotic articulation between the convex surface of the distal fibula and the concave distal tibia (Vogl TJ, 1997). The distal fibula is firmly attached at the fibular notch of the tibia by several syndesmotic ligaments. The stability of this articulation is integral in allowing proper functioning of the ankle and lower extremity. The ligaments that stabilize this joint are the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, and the interosseous ligament. The most distal and inferior aspect of the interosseous membrane also helps to stabilize this joint.

The anterior inferior tibiofibular ligament is a flat, strong ligament. It originates from the longitudinal tubercle on the anterior aspect of the lateral malleolus, and the fibers course superiorly and medially, attaching on the anterolateral tubercle of the tibia. The fibers of this ligament increase in length from proximal to distal, with the most distal fibers being the longest. In addition to holding the fibula tight to the tibia, this ligament prevents excessive fibular movement and external talar rotation.

The posterior inferior tibiofibular ligament has superficial and deep components. The superficial fibers originate widely on the posterior tubercle of the tibia and run obliquely, distally, and laterally to the posterior lateral malleolus. This ligament works with the anterior inferior tibiofibular ligament to hold the fibula close in the fibular groove of the tibia (Singer KM, 1995). The deep component of the posterior ligament is the transverse tibiofibular ligament. Some anatomists consider this ligament to be independent from the posterior inferior tibiofibular ligament. The transverse ligament is a thick, strong structure with twisting fibers. It passes from the posterior tibial margin to the osteochondral junction on the posterior and medial margins of the distal fibula. The location of the transverse ligament below the posterior tibial margin helps it to prevent posterior talar translation. The ligament creates a posterior labrum, which deepens the articular surface of the distal tibia. It also fills in the posteromedial aspect of the lateral malleolus, deepening the mortise and increasing joint stability.

The remaining ligament of the distal tibiofibular syndesmosis is the interosseous ligament. Originating at the anteroinferior triangular segment of the medial aspect of the distal fibular shaft, this ligament then courses to insert on the lateral surface of the distal tibia. The interosseous ligament is a thickening of the distal aspect of the interosseous membrane and is thought to act as a "spring," allowing for slight separation between the medial and lateral malleolus during dorsiflexion at the ankle joint.

Ogilvie-Harris et al (1994) studied the relative importance of each of the syndesmotic ligaments in the distal tibiofibular articulation. They tested 8 fresh-frozen cadaver specimens on a hydraulic system to evaluate the percentage of contribution of each ligament during 2 mm of lateral fibular displacement. The anterior inferior tibiofibular ligament provided 35%; the transverse (deep posterior) ligament, 33%; the interosseous ligament, 22%; and the superficial posterior inferior ligament, 9%. Thus, 3 major ligamentous components provide stability to the syndesmosis, accounting for more than 90% of the total resistance to lateral fibular displacement. Injury to one or more ligaments results in weakening, abnormal joint motion, and instability.

2.2 Movement of the Ankle

The primary motions of the ankle joint occur within the sagittal plane: dorsiflexion and plantar flexion. Dorsiflexion can be described as movement of the top of the ankle and foot toward the anterior aspect of the tibia. Plantar flexion is movement of the ankle and foot away from the tibia. The normal ankle allows approximately 15° to 20° of active dorsiflexion and between 45° and 55° of active plantar flexion (Thompson, 1998). Sarrafian (1993) reported about 24° of sagittal plane motion at the ankle during the stance phase of gait. Maximal dorsiflexion is approximately 10° during the stance phase of normal running and 14° for plantar flexion. As for most joints with passive ranges of motion greater than active ranges, the full weight-bearing ankle passively allows up to 40° of dorsiflexion (Thompson, 1998).

The articular surfaces of the talus and malleoli remain in contact as the ankle moves from dorsiflexion to plantar flexion. The superior talar surface is wider anteriorly than posteriorly, with an average difference of 4.2 mm (Sarrafian, 1993). During dorsiflexion, the wider anterior portion of the talus "wedges" between the medial and lateral malleoli, and much of the mortise becomes occupied. This position is considered the safest for the ankle due to the increased joint stability that results from this close packing of the bones and increased contact of the articular surfaces. The wider anterior aspect of the talus moves out of the mortise during plantar flexion (loose packing), thus decreasing the ankle's bony stability (Turco VJ, 1977).

Despite some decreased bony stability in full plantar flexion, the posterior two thirds of the talar dome remains in the mortise as the result of talar rotation. Close JR (1973) documented 5° to 6° of talar external rotation during both active and passive ankle dorsiflexion. During plantar flexion, the talus internally rotates as a result of its conical and wedged shape. Sarrafian (1993) reported that, in addition to rotating internally, the talus also supinates slightly during plantar flexion. This, in turn, causes posterolateral wedging of the talar trochlea. As plantar flexion increases, wedging between the posterolateral trochlea and lateral malleolus increases correspondingly. During dorsiflexion, therefore, the talus must pronate, a fact that may be important in the many tibiofibular ligament injuries occurring from dorsiflexion and external rotation.

Lundberg et al (1989) using roentgen stereophotogrammetry, evaluated talar motion during weight-bearing tibial rotation. They reported triaxial talar movement when the leg was either externally or internally rotated. Tibial external rotation of 10° caused the talus to dorsiflex 4.3° ± 3.5°, supinate 1.5° ± 1.6°, and laterally rotate 0.7° ± 2.5°. Internal tibial rotation of 20° resulted in talar lateral rotation equal to 5.0° ± 2.0°, pronation equal to 0.7° ± 0.5°, and plantar flexion of 0.1° ± 1.9°.

Inversion, eversion, supination, and pronation primarily occur at the subtalar joint. Inversion is inward turning of the sole of the foot, whereas eversion is outward turning. Supination is a combination of calcaneal inversion, foot adduction, and plantar flexion, whereas pronation is calcaneal eversion, foot abduction, and dorsiflexion. The normal ranges of motion for subtalar inversion are approximately 20° to 30°, whereas ranges for eversion are between 5° and 15°.

During ankle plantar flexion and dorsiflexion, some movement normally occurs at the distal tibiofibular syndesmosis. When the foot is moved from a plantar-flexed position to a dorsiflexed position, the joint permits approximately 1 to 2 mm of widening at the mortise (Stiehl JB 1990). Movement of the fibula occurs at and affects the tibiofibular syndesmosis. While in the fibular groove of the tibia, the fibula rotates around its vertical axis when the ankle is plantar flexed and dorsiflexed. Lateral fibular rotation is approximately 3° to 5° with dorsiflexion, and medial rotation is 3° to 5° with plantar flexion (Stiehl JB 1990).

2.3 Function of Fibula

2.3.1 Muscle and crural / interosseous attachment

The fibula is a long, thin bone whose length functions statically as a proximal attachment site for the plantar flexors (soleus, tibialis posterior, flexor hallucis longus, peroneus longus, and peroneus brevis) and some of the extensors (peroneus tertius, extensor digitorum longus, and extensor hallucis longus) of the ankle and digits of the foot (McCullough CJ, 1980).

The anterior crural intermuscular septa originates from the anterior border of fibula and separates the extensor compartment from the peroneal compartment. The interosseous membrane originates from the medial border of the fibula and separates the extensor compartment from the deep posterior compartment. The medial crest gives attachment to four transverse crural intermuscular septum, which is the landmark for the course of peroneal vessels near fibula. The posterior crural intermuscular septum separates the lateral compartment from posterior compartment.

2.3.2 Ankle stability

The fibula also has an important dynamic function in maintaining ankle mortise stability during weight bearing. Scranton et al (1979) reported, in a radiographic study of 10 ankles, an average fibular migration of 2.4 mm inferiorly in weight bearing. This distal movement is the result of contraction of the foot flexors, which attach proximally on the fibula. Downward fibular movement deepens the ankle mortise and tightens the interosseous membrane, resulting in a more acute angle of the membrane's fibers and pulling of the fibula medially. The deepened mortise and taut interosseous membrane provide additional lateral support to the ankle during both the stance and push-off phases of gait (Stiehl JB, 1990). The fibula may move proximally or rotate laterally to accommodate the talus with ankle dorsiflexion during functional motions (Ogilvie-Harris DJ, 1994)

The lateral malleolus has been referred to as the key for anatomic reduction of displaced ankle fracture, and its integrity reestablishes the stability of the ankle (Yablon at al. 1977). According to McCullough and Burge (1980), malreduction of the distal fibula result in rotation and lateral shift of the talus with permanent instability and valgus tilt of the ankle. They also emphasized that the restoration of the length and proper rotation of the fibula is an absolute priority and even, a minimal degree of shortening of the fibula is indication for the operative treatment. Few authors had noted shortening of the fibula due to proximal migration of residual distal fibula in some patient (Lee et al. 190; Goh et al. 1992; and Babhulkar et al. 1995). Apart from proximal migration, Goh et al. (1992) also noted that fibula resection left on mobile distal remnant, which was unable to resist pressure from the talus during weight bearing.

Lang et al. (1988) had performed a biomechanical study of the ankle syndesmosis after harvesting fibular grafts. They carried out two experiments by using cadaveric tibias/fibulas to determine the ability of the ankle syndesmosis to resist both lateral and vertical displacement of the intact fibula, as well as lateral and vertical displacement of the distal fibular stump after serial fibular osteotomies had been made at distance of 14,10,6 and 4 cm from the tips of the lateral malleolus. The results of this study showed that, once the fibula was cut, the syndesmosis provided significantly less resistance to lateral and vertical displacement. Although this resistance continued to decrease with each decrease in fibular stump length, the length of the fibula stump did not significantly affect the stability of the syndesmosis.

According to Uchima E (2007) the whole fibula including the head is essential for the stability of the ankle joint complex and the distal fibula is responsible for the stabilizing the ankle mortise during external rotation and inversion. He recommended fixation of the syndesmosis or bracing to prevent ankle joint instability especially when the distal fibula is shortened 6 cm or more.

2.3.3 Weight bearing

The fibula has also been found to function in weight bearing, bearing approximately 6.4% of the applied loads, according to Takebe et al (1984) These researchers also reported that fibular weight bearing increased when the ankle dorsiflexed and decreased when the ankle plantar flexed. This change in fibular loading may be explained by fibular elevation in dorsiflexion and fibular lowering in plantar flexion. Wang et al (1996) suggested that the fibula carries load between 10% and 30% of a static axial load. The proportion of the load on the fibula heightened when the load was increased or displaced laterally and when the ankle was dorsiflexed. These results suggest that fibular loading varies during normal activities and under abnormal situations.

Wang et al. (1996) performed a study on anatomic lower limb specimens to assess the role of the fibula in weight bearing. He noted that the proportion of the load carried by the fibula increased with total loading. With loading, the lateral malleolus migrated distally relative to the medial malleolus, except after fibula osteotomy, when it migrated proximally. Cutting the inferior tibiofibular ligament reduced the propotional load in the fibula and increased its distal migration. The interosseous membrane modified the load distribution between the tibia and the fibula, with the distal fibula carrying a higher proportion of the axial load than did the proximal.

Skraba JS (1984) study the role of the interosseous membrane on tibiofibular weightbearing. The interosseous membrane was found to play a critical role in the load-sharing ability of the fibula. After incision of the membrane, fibular strain decreased to essentially zero. An intact membrane keeps the fibula active during the loads and motions of normal gait.

2.4 Fibular graft

Fibula is not the main weight bearing bone of the leg. Only its upper three quarters serve to give attachments to the adjacent muscles. Therefore, removal of this segment of the shaft has no significant effect on the ankle stability and renders it as being a suitable donor for both conventional and microvascular bone transplantations.

2.4.1 Nutrient foramen

A study by McKee et al. (1984) on 305 fibula showed that the most frequent finding was a single nutrient foramina (86.4%) followed by two foramina (7.7%). It was surprising that about 5.6% of fibula in McKee series had no visible nutrient foramina. This was quite similar with the findings by Restrepo et al. (1980), which reported that four of 100 fibula lacked of nutrient foramina. McKee et al. also showed that most nutrient foramina was mostly located near the midpoint of the fibular shaft, with the middle third of the shaft included 96% of the foramina. This finding was in agreement with that of Taylor (1975). The diameter of the foramen in McKee series was between 0.5 mm - 0.7 mm in 65% and between 0.71 mm – 1.10 mm in 34.6% of the sample. In relation to the cross sectional surface of the fibula, McKee et al. found that the