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Reconstruction of Mandible Using Non-Vascular Fibula Graft: Review of Literature.

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Abstract

Reconstruction of defect in the maxillofacial skeletal bones creates a great challenge to oral & maxillofacial surgeon. The reconstruction of the defect is a major challenge in maxillofacial surgery due to aesthetic and function. Auto graft, prosthetic replacement, or allograft-prosthetic composite grafts are well known technique for maxillofacial reconstructions. Fibula is a workhorse osseous flap for mandibular and maxillary reconstruction. The nonvascularized autologous bone graft has been exercised for more than 100 years, most particularly for reconstruction after resection of bone tumors or trauma (1), with the first application of a fibular graft was depicted by Walter in 1911. The vascular fibula flap was first described by Ian Taylor, On April 7, 1974 to reconstruct parts of the tibia. In 1989 New York, the first reconstruction of defect of the mandible with a free fibula flap was done by David Hidalgo. Fibula is a workhorse osseous flap for mandible and maxillary reconstruction (2, 3). When, non-vascularized bone grafts utilized for maxillofacial skeletal bones defect it integrate into the contiguous host bone during the course of "creeping substitution." The bone graft material, through the invasion of capillaries, perivascular tissue, and inflammatory cells, is progressively revascularized and in due course resorbed, permitting for the creation of new living bone which is integrated and remodeled into the host skeleton.(4). We present the review & case study on non-vascularized fibula reconstructions of the mandible after ablative tumour surgery. The aim of this case review explores the Surgical Anatomy, Surgical Technique, Indications, Contraindications and Complications of non-vascularized fibula bone graft.

Keywords: Alveolar squamous Cell Carcinoma, fibula bone graft, maxillofacial reconstruction, vascularized bone grafts.

Introduction

A defect in the maxillofacial skeletal bones creates a great challenge to oral & maxillofacial surgeon. These can occur due malignancy, high-energy trauma, and atrophic non-unions. If left untreated, these can lead to unacceptable shortening and aesthetics along with loss of function. Auto graft, prosthetic replacement, or allograft-prosthetic composite grafts are well known technique for maxillofacial reconstructions.

The nonvascularized autologous bone graft has been exercised for more than 100 years, most particularly for reconstruction after resection of bone tumors or trauma (1), with the first application of a fibular graft was depicted by Walter in 1911. The vascular fibula flap was first described by Ian Taylor, On April 7, 1974 to reconstruct parts of the tibia. In 1989 New York, the first reconstruction of defect of the mandible with a free fibula flap was done by David Hidalgo. Fibula is a workhorse osseous flap for mandible and maxillary reconstruction (2, 3). When, non-vascularized bone grafts utilized for maxillofacial skeletal bones defect it integrate into the contiguous host bone during the course of "creeping substitution." The bone graft material, through the invasion of capillaries, perivascular tissue, and inflammatory cells, is progressively revascularized and in due course resorbed, permitting for the creation of new living bone which is integrated and remodeled into the host skeleton.(4)

We present the review on non-vascularized fibula reconstructions of the mandible following ablative tumour surgery. The aim of this case review explores the Surgical Anatomy, Surgical Technique, Indications, Contraindications and Complications of non-vascularized fibula bone graft.

Discussion

Surgical Anatomy: The fibula is much slimmer than the tibia and is indirectly implicated in transmission of weight. It has a proximal head, a thin neck, an elongated shaft and a distal lateral malleolus. The width of adult fibula is 1.5 to 2cm and length 35 cm, out of which 25 to 30cm can be harvested.(5)

The fibula has a dual vascular supply through its periosteal & endosteal vessels. A nutrient artery that normally joins the posterior fibular cortex at the junction of the proximal one-third and distal two-thirds provides the endosteal blood supply to the fibularis. This nutrient artery is a branch of the peroneal artery (Fig.1), which runs along the posterior aspect of the fibular diaphysis. Besides the nutrient vessel, through a variety of segmental musculo-periosteal vessels which also arise from the peroneal artery provides the fibula additional vascularity. The venous drainage is through two peroneal venae comitante which runs parallel to the fibula. Harvesting technique should aim to preserve both the nutrient artery and the rich periosteal blood supply. (6) The common peroneal nerve passes around the head of the fibula from the posterior aspect. It splits into a superficial peroneal nerve that provides the lateral aspect of the leg a cutaneous sensation and concludes as the lateral sural cutaneous nerve. The lateral sural cutaneous nerve arises within or above the popliteal fossa.(7)

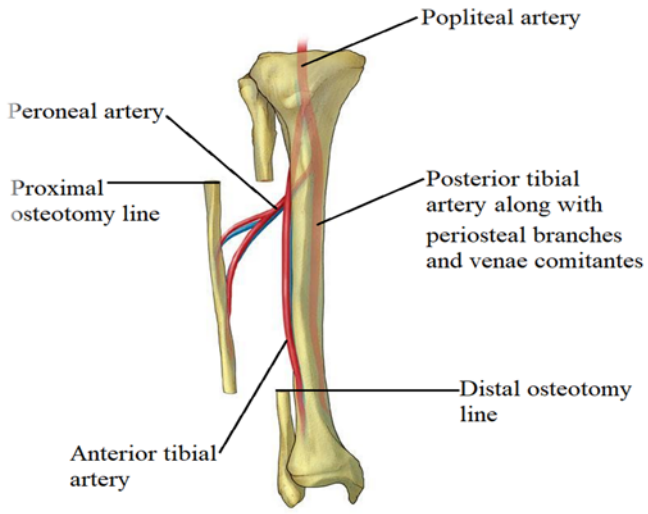

Fig.1: Showing diaphyseal fibular graft, if long segment is required and the osteotomy is closed to the lateral malleous, screw fixation to tibia advised to prevent vagus deformity & ankle instability.

Surgical Technique: Comprehensive hemogram, serum calcium, serum phosphorus and serum alkaline phosphatase, radiography of relevant section using computed tomography, skeletal examination, and

histopathological analysis was performed pre-operatively and phosphorus and serum alkaline phosphatase were studied etc. Under general anesthesia with tourniquet control, a sand bag was kept beneath the pelvis and a pillow beneath the leg. The patient is positioned supine on the operating table with the hip and knee slightly flexed and internally rotated and maintained in that position. The entire lower extremity is prepared and draped in standard fashion with circumferential exposure up to the groin. (7, 8)

In the minimally invasive harvesting technique of non vascularized fibular graft, the site planned for the osteotomy was at least 8 cm (8 to 10cm) from the distal fibula so as not to risk destabilizing the ankle. (Fig.2, 3) The proximal end of the fibula was at least (4 to 5cm) 6 cm from the site to remain sufficiently distant from the fibular nerve as well as maintain knee stability. (9).

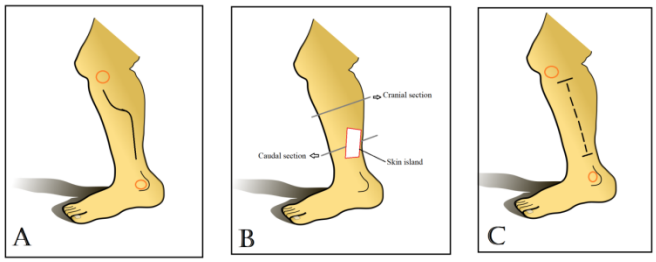

Fig. 2 A) the incision line, starts 6cm distal of the fibular head so as to preserve the common peroneal nerve, which crosses the fibular neck proximal to this mark. Incision extends from the lateral to the medial aspect of the underlying posterior intermuscular septum. Incision line stops 6cm proximal to the lateral malleolus to avoid instability of the ankle. B) Location of the cranial and caudal cross-sections of the lower leg and its relation with the proposed skin paddle. C) Skin markings for the minimally invasive harvesting technique of non vascularized fibular graft.

In the classical approach harvesting technique of non vascularized fibular graft, The incision begins at the anterior margin of the skin island and is extended proximally and distally to within 6 cm of the fibular head and lateral malleolus, respectively, to a level below the superficial fascia. The incision line extends from the lateral to the medial aspect of the underlying posterior intermuscular septum, separating the soleus muscle from the peroneus longus muscle. (6)

The superficial and deep fasciae were divided. A plane between the posterior soleus muscles and the anterior peroneal muscles has been established. The fibular diaphysis approach was used after opening the crural fascia and identifying the space between the soleus and fibular muscles, care being made to preserve the periosteum and periosteal blood supply; this results in the typical “marbled” appearance to the fibular graft.

Anteriorly and posteriorly, circumferential fibula dissection is continued, reflecting the peroneal and flexor hallucis longus muscles. The peroneal artery and vein are found along the posterior side of the fibula and carefully protected as the intermuscular septum is divided over the length of the planned graft. (10) As per the roof head cut fashion, the proximal and distal end of the proposed fibula is cut, which means the length of the outer cortex is more than the length of the inner cortex. A bone holding forceps grips the distal cut end of the fibula and gently pulls it out to reach the interosseous border. The bicep femoris tendon and fibular collateral ligament were sutured into the neighboring soft tissues after the resection was finished. (11)

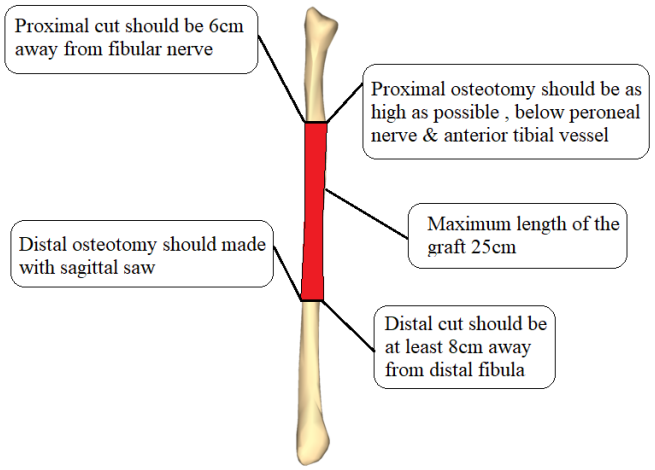

Fig. 3: planned Harvest of fibula graft using proximal and distal osteotomies with Gigli saw or oscillating saw.

Closure of the donor site is achieved with loose approximation of muscles and suturing of the flexor hallucis longus to tibialis posterior to optimize postoperative great toe flexion. A suction drain is placed and secured.The donor defect skin paddle is reconstructed by a split-thickness skin graft obtained from the thigh, accompanied by the implementation of a bolster and posterior splint. (6)

Indications

1) Indicated for reconstruction of upper extremity segmental bone defects Greater than 6 – 8 cm. It can also be used for smaller bone defects with skin loss. 2) Indicated in bone gaps of any size where prior attempts at bone grafting have failed. 3) Traumatic bone loss. 4) Tumor resection. 5) Osteomyelitis 6) Infected nonunion 7) Persistent nonunion 8) Osteonecrosis 9) congenital pseudarthrosis. 10) Osteocutaneous fibula flap is particularly used in cases where skeletal deficiencies occur along with the moderate soft tissue loss. (11)

Contraindications

1) The free flap is relatively avoided in patients with severe atherosclerotic disease of lower extremity. 2) Around 5-7% of patients have singular vascular supply to the lower leg & foot, peroneal artery being the dominant vessel. In such cases contralateral leg can be used for graft or alternatively a vein graft is needed to reconstruct peroneal artery.

Complications

Recipient Site – 1) Anastomotic thrombosis and loss of flap viability 2) Nonunion 3) Infection 4) Hardware failure and breakage.

Donor Site – 1) Valgus ankle deformity 2) Ankle joint instability or limitation in knee or ankle joint movement range. 3) Moderate laxity of the lateral collateral ligament at the knee. 4) Fracture of the tibia. 5) Transient peroneal nerve paralysis has been reported in the literature. Weakness in the extensor hallucis longus muscle was examined by Shingade et al, after nonvascularized fibular harvesting,:38% of patients felt postoperative weakness that resolved secondarily 6) Scarring complications after open harvesting have been reported. (6, 12)

Conclusion

Reconstruction of defect in the maxillofacial skeletal bones creates a great challenge to oral & maxillofacial surgeon. The reconstruction of the defect is a major challenge in maxillofacial surgery due to aesthetic and function. The unique anatomy of mandible necessitates use of complex reconstruction while receiving donor bone graft. Fibula is a workhorse osseous flap for mandibular and maxillary reconstruction. Relatively long length, straight contour, and strength of cortical bone make it the preferred donor site for reconstruction of long bone defects. Complications associated with conventional technique of harvesting fibular graft is greatly reduced in recent years after introduction modified, minimally invasive technique.

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