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Vascularised Free Fibular Graft for Reconstruction of Extensive Bone Defect in Nigeria Using Simple Basic Tools: How Feasible and Review of the Literature

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Authors' contributions

Both the authors made substantial contributions in the study design, implementation and write up.

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Case Study

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ABSTRACT

Background: Segmental defects in long bones from any cause often present significant challenge to trauma reconstruction and orthopaedic surgeons. Various options for bridging extensive segmental bone defects have been tried in attempt to find the best method to achieve that. In developing countries, the choices are limited due to unavailability and high cost of sophisticated implants and materials, and the relative lack of expertise and equipment required to carry out some of these procedures.
Setting: University of Port Harcourt Teaching Hospital Port Harcourt, Nigeria.
Case & Review: This article reports the first use of a free vascularised fibular graft to bridge a long segmental defect in the radius following tumour resection in a tertiary hospital in Nigeria and perhaps the sub region and reviewed the feasibility of such procedure using basic simple tools
Conclusion: Free vascularised fibular graft is an option for bridging large bone defects in Nigeria as long as the required expertise, capacity and facilities are available. It can be less complicated and more economical in well selected patients in the long run compared to other complex reconstruction methods especially if the expertise and basic resources is available.

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1. INTRODUCTION AND REVIEW OF LITERATURE

Management of long segmental bone defects in long bones from any cause can be very challenging to both the patient and the managing orthopaedic and reconstruction surgeon. Various methods have been described for reconstruction of long segmental bone defects following trauma or surgical treatment of bone infections and tumours. Such methods include the use of autologous non vascularised strut graft [1] and distraction osteogenesis [2], endoprosthesis [3], allografts [4], allograft-prosthetic composites [5]. The listed methods have various limitations and complications thereby limiting the application of each method for large segmental defects [6].

For defects involving the fore arm, common treatment options for forearm instability may include functional bracing, activity modification, internal or external fixation with bone grafting, structural grafts of allogenic or autologous cortical bone. Other options include large-volume autologous cancellous bone grafts, or distraction osteogenesis [2]. Although amputation is an option, poor results from upper extremity prosthetics are well known [7]. Unavailability of functional prosthesis in developing countries has been a major challenge. In addition, amputation is not readily accepted as an option of treatment in Nigeria for reasons of social, economic and cultural stigma associated with amputations especially in the upper limb [8].

Vascularised autologous bone graft for long bone reconstruction has been used to bridge large and long intercalary bone defects for over 30 years, following resection for bone tumours or infection [9,10,11,12]. The challenge of the use of vascularised fibular graft is the technical skill required to perform such procedure and the expensive equipment and tools required for such complex procedure which limits its use in most developing and resource challenged regions. The advantages of vascularised fibula grafting for large segmental bony defects include immediate structural support, the potential for graft hypertrophy, relative resistance to infection by virtue of the preserved blood supply and a reduced reliance on the envelope of surrounding soft tissue for graft incorporation and healing [13]. In situations when the defect site is had been infected, or the defect longer than 6 cm, or has not responded to other conventional treatments, use of vascularised bone graft becomes attractive [8].

The fibula is one of the few expendable long bones in the body, with up to 25 cm of available bone for reconstruction [14]. It has been described as “the work horse” of the musculo-skeletal reconstruction surgeon [15]. The pedicle length of the fibular averages 6 cm, with a vessel diameter of 2 to 3 mm as such requires minimal magnification for anastomosis of the vascular pedicle. It is vascularised through an endosteal and periosteal blood supply. The nutrient artery enters in the upper middle third of the fibula and supplies the endosteal circulation. The periosteal blood supply is through four to six peroneal perforators that are 3 to 5 cm apart and allow for multiple osteotomies. Although the fibula can survive on either the endosteal or the periosteal blood supply, it is best to preserve both supplies if possible to maximize the vascularity of the fibula [8]. The use of free vascularised fibular graft is not without limitations and draw backs which include failure of the transplanted bone to incorporate, difficulty to assess the patency of the anastomosis in the immediate post operative period.

Although some authors have reported the use of non-vascularised fibular graft transfers to bridge bone defects even in the region, [16,17,18]. There is however a limited length of defects that can be bridged using non-vascularised free bone graft. Most authorities limit the length below 7cm [15]. A search of the literature showed that there has not been any report of the use of vascularised autologous free fibular graft for musculo-skeletal reconstruction in Nigeria predating this operation. Relative lack of expertise and facilities for micro-vascular surgery in most centres in the region limits the use of vascularised bone grafts as an option for the reconstruction of large defects.

This report presents perhaps the first successful use of vascularised free fibular graft to bridge segmental defect of the fore arm using simple basic tools in the sub region. The vascularised free fibular graft was used for the reconstruction of an extensive radial defect following tumour resection using basic tools which is readily available in most centres.

2. CASE DESCRIPTION

Mr J. A, is a 30 yr old right hand dominant businessman who presented on November 2009 with a six month history of a swelling of the distal right forearm close to the wrist joint. The mass was said to have been noticed a week after a trivial trauma to the right wrist. There was a gradual progressive increase in the size of the mass with associated mild to moderate pain over the swelling, and distal parasthesia. The motor function his right hand was intact. However, he was unable to use the hand optimally because of the pain and progressive deformity. There was no history of similar previous or concurrent swellings, there was no fever, weight loss, chronic cough or night sweats. He is not a known hypertensive or diabetic, has had no previous admissions, or surgeries, no known drug allergies. No similar ailment in any family member, he does not take alcohol or tobacco products in any form. Systemic review was unremarkable.

He had visited some traditional bonesetters where incisions were made over the mass and some local herbal concoctions applied. There was a progressive worsening of his pain and an increase in the size of the mass hence his decision to come to the hospital for further treatment.

On examination at presentation, he was not in obvious painful distress, healthy looking young man, apart from the large mass on the radial aspect of distal right forearm, extending to the wrist, measuring about 10 cm x 8 cm x 4 cm. With obvious scarification marks and some hyperpigmentation. Large superficial veins were present over mass. The mass was found to have originated from the radius, with varied consistency, from soft to firm to hard at different areas. The distal radio-ulna joint was dislocated. The radial pulse was palpable over the mass in a transmitted fashion, and the sensation of the hand distal to the mass was intact. His right hand grip power was grade 3. His chest and abdominal examinations were unremarkable.

Radiographs revealed a tumour of then right distal radius, extending from the wrist to the junction of the distal and middle third of the bone, approximately 10 in length. There were multiple cystic/ lytic areas within the mass. The cortex was intact in some areas but was broken in other areas.

The histopathology report of an incisional biopsy of the mass confirmed the mass as an aneurismal bone cyst. The mass was subsequently widely excised and a repeat histology done, which confirmed the diagnosis. The patient was however left with a defect of about 14 cm in the right distal radius, associated with wrist instability which was in radial deviation.

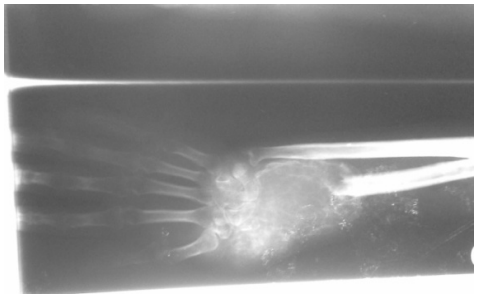
Following an informed consent, the patient opted for limb salvage with vascularised free fibular graft to bridge the defect 15th December 2011. The right fibula was subsequently harvested with its blood supply and used to bridge the defect. The fibular graft was fixed proximally and with a dynamic compression plate and distally with a T-plate which was used to fuse the right wrist. The fibular vessels were anastomosed to the radial artery and vein. Intra operative magnification was by use of simple operating loupes for the surgeon and the assistant, while vascular anastomoses was done using mini-fragment instruments from the ophthalmology unit and vascular tapes used to maintain haemostasis during the anastomoses using Rummel's method [19].

Post operative antibiotics, analgesia, wrist splinting and anticoagulants were given. He was discharged ten days later.

On follow-up at 6 months, the operation wound had healed completely and the fused right wrist was stable with good functional right hand. A check radiograph showed good bridging union at the proximal fixation between the fibula and proximal stump of the radius and distal fixation between the metacarpals and fibula.

3. DISCUSSION AND REVIEW

Reconstruction of extensive bone defects has been a major challenge for orthopaedic surgeons worldwide and especially in resource limited regions including Nigeria. The major challenges include relative lack of the availability of endoprosthesis [1] and bone graft substitutes [3]. Even when these items are available, the high cost of the products makes them unaffordable to majority of the patients.




Figs. 1 and 2. Pre - tumour resection X-rays (AP & Lateral) views

Options such as bone transport and non-vascularised fibula strut graft to replace large bone defects has been reported in literature with varying degrees of success [1,2,3,4]. Limitations in resources, and possible complications associated with non-vascularised bone grafting [20] and bone transport has also been recorded [2]. In this particular case, it would have been almost impossible to harvest enough bone graft required to fill the defect as it would have required multiple harvests at different sites of the body. In addition, the choice of bone transport would also not have been possible as it would have taken almost 1 year to bridge the defect. In addition, the size of the residual radial stump after the wide excision of the tumour would have made it impracticable in this particular case.

Fig. 3. Harvested fibular

Another option would have meant, leaving the patient with only the ulna which may not be able to support the wrist functions considering that the patient's activity of daily living requires regular use of his right hand for physically demanding activities. The other available option included amputation. Just like most patients in the region, amputations as a choice of treatment was bluntly rejected by the patient for reasons that had been highlighted [11]. In addition amputation for a non-malignant lesion such as ABC would have been very distressful for both the patient and the managing team.

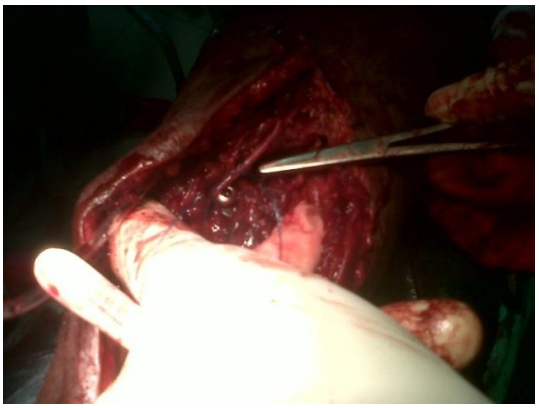


Fig. 4. Anastomosed vascular pedicle

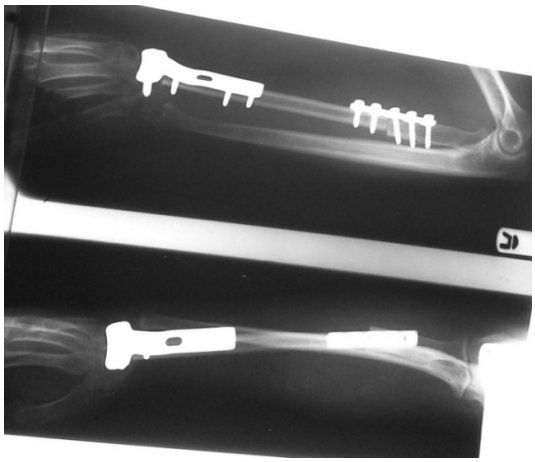


Fig. 5. Immediate post vascularised fibula transfer radiographs

The only other option available that was considered viable was the use of vascularised autologous free fibular graft. Autologous

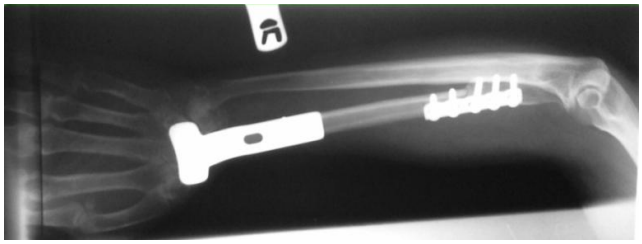


Fig. 6. 6 months follow-up radiographs showing incorporation of transferred fibula

Figs. 7 & 8. 6 months follow up: Functional assessment

vascularised free fibular graft has been used by various persons to reconstruct extensive bone defects in the body with good outcome [14,15].

The advantages of using an autologous graft instead of allografts or artificial implants include less immunological and infectious complications respectively [14]. The use of vascularised free fibular graft is not without difficulties, complications and disadvantages which include prolonged and complex surgical procedure, sacrifice of major vessels and difficulty in assessing the patency and viability of the anastomosed vessels in the immediate post operative period. Other limitations of using vascularised free fibular graft is the availability surgeon with required skills, availability of intra operating microscopes for magnification and availability of specialised vascular instruments required for vessels' mobilisation and vascular anastomosis. The skills for vascular anastomosis are among the basic skills required of surgeons during the early years of residency training in most post graduate training programs including the West African College of Surgeons who adopted the Basic Surgical Skills Course from the Royal College of Edinburgh [20]. However, a review of skill availability shows that most surgeons who practising in the region lack such skills. Many see such vascular procedure as only reserved in the purview of the microvascular reconstruction surgeons. Because of this reason, some persons with potentially salvageable injuries and lesions requiring vascular anastomosis have lost their limbs in the region. Whereas that view may be correct, in the phase of limited availability of such specialised skills and manpower, available surgeons in the region may have to improve their skills and knowledge of such basic vascular procedures since most

persons in the region often would not accept amputation as a form of treatment.

In this case intra operative magnification was achieved by the use of operating loupes by the surgeon and the assistant. The idea that operating microscope has to be available to undertake such complex procedure should be discounted especially for vasularised free fibular transplant as the size of the pedicles of the fibular vessels require minimal magnification to be able to undertake its anastomosis. Some surgeons had blamed lack of operating instruments as part of the factors limiting availability of this procedure in most centres. This is not the case in this operation as the instruments for vascular anastomosis was achieved using mini-fragment instruments borrowed from the ophthalmology unit. It does appear that the unavailability of instruments for vascular anastomosis may not be due to lack of funds rather due to lack of interest in their need by the relevant authorities since these instruments although specialised can be sourced and procured just like instruments used for other special surgeries such as in ophthalmology. Other reasons commonly given for inability to undertake such procedures requiring vascular anastomoses include lack of special vascular clamps required for the procedure. Vascular tape which is readily available was used as substitute for the specialised non-crushing vascular clamps. Whereas vascular tape was used as clamps using Rummel's method [19] to secure proximal and distal vascular control in this procedure, efforts should be made to procure appropriate clamps such as the bulldog clamps required for such complex vascular anastomosis.

Post operative aesthesis was acceptable and functional outcome assessment of the right wrist was categorised as satisfactory (70%) using the Mayo's Wrist Outcome Score [21].

This report and review aimed to show that free vascularised fibular graft transfer is a feasible option for bridging large bone defects, even in resource scarce countries such as Nigeria, provided the required expertise is available. Care givers should explore all options available for optimal care of patients.

4. CONCLUSION

Free vascularised fibula grafting is an option to consider for bridging long segmental bone defects. It is advantageous in terms of surgical outcome and cost especially if basic tools can be improvised for such complex procedures. Surgeons with experience in vascular and micro vascular surgery should play roles in providing the expertise required to manage these common and often challenging medical problems in the region. Patients requiring such treatment from centres where this skill may not be presently available should be referred to centres where such procedures can be performed for optimal patient outcome. This will save such patients the risk of prolonged and costly treatments and avoidable amputations. Efforts should be increased to train more surgeons in the skills of vascular anastomosis and micro vascular surgery since situations requiring such complex reconstructions abound in the region.

ETHICS APPROVAL

Study was approved by the Research and Ethical Review Committee of University of Port Harcourt Teaching Hospital according to Helsinki declaration 1975.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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