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Non-Vascularised Fibula Graft: Hospital Sultan Ismail Experience of 6 Cases

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Abstract: ***Background: Non-vascularized fibular bone graft was reliable surgical method for managing bone defect after bone tumour resections. Objective(s): To review the outcome of non-vascularised fibular bone graft with bone defect after tumour resection in terms of union, time of union and complications. Method: This a case series reviewing retrospective medical record review of all patients with bone defect after bone tumour resection managed with non-vascularized fibular bone graft over 5 years in a Hospital Sultan Ismail. Results: There were 6 patients with 4 patients had union and 2 patients did not unite with median time for union was 24 weeks. One patient had stress fracture after union. Conclusions: Non vascularised fibular graft use in management of bone defect after bone tumour resections is still a good surgical option despite advancement of vascularised fibular graft.***

Keywords: Non vascularised fibular bone graft, bone defect, bone tumour resection, Hospital Sultan Ismail

1. Introduction

Reconstructing extremities in patients afflicted with a large bone defect after tumour resection presents challenges in terms of preservation of limb length, post-surgical functional outcome while having an aesthetically acceptable appearance. Current surgical options include biological reconstruction of the bone defect using either an autograft or an allograft. Options for autograft bone grafting are divided to vascularised fibular graft or non-vascularized fibular bone graft (NVFBG).

NVFBG has been used since 1911 for management of bone defects. While the advent of vascularized fibular grafts can be traced back to the groundbreaking work of Taylor heralding a surge in their widespread adoption for the reconstruction of long bone defects [1]. Despite this advancement, non-vascularized fibular bone grafts still have reasonably favourable outcomes and offer a degree of technical simplicity when compare with the intricate microsurgical demands necessitated by vascularized fibular grafts[2].

The fibula, with its tubular morphology, emerges as an optimal candidate owing to its innate characteristics that make it well-suited for addressing substantial bone defects. Notably, its inherent length, geometric conformity, and robust mechanical properties renders it particularly amenable to non-vascularized bone graft procedures. Fibula's adaptability and extensive applicability in managing defects more than 12centimetres in length, highlighting its versatility in addressing diverse bone defects [2]-[3].

Another advantage of the fibular graft lies in its ability to conform to the size and shape of various recipient bones, including the radius, ulna, tibia, femur and humerus. This structural congruity facilitates a snug and precise fit within the medullary cavities of these bones, thereby augmenting stability and fortifying resistance against angular and rotational stresses.

Furthermore, the fibular graft's compositional attributes, characterized by a substantial proportion of cortical bone and a triangular configuration, contribute significantly to heightened stability and bolstered structural integrity. Notably, minimal morbidity at the donor site further solidify the fibula's preference in non-vascularized bone grafting procedures, enhancing its appeal as a grafting source in orthopaedic reconstructive.

2. Methodology

This is a retrospective caseseries of six patients, who underwent treatment with NVFBG for a bone defect following tumour resection from 2015 until 2020 in Hospital Sultan Ismail. For every case, we collecting data regarding union, time to union and complications if any. All surgeries were performed by surgeons experienced in managing musculoskeletal tumour and bone defects. Descriptive analysis was used to describe the clinical outcomes.

3. Case Discussion

Case 1
23 years old, male complains of swelling and pain of the left ankle. X-ray showed an expansile lytic lesion over the distal left tibia. MRI revealed an expansile osseous lesion with fluid-fluid level. Tru-cut biopsy HPE was reported as Giant Cell Tumour. Wide local resection resulted in a bone defect of 16cm. Ankle fusion was done with NVFBGand union was achieved after 24 months.

Case 2
80 years old, male with underlying End Stage Renal Failure on regular haemodialysis, was diagnosed with Squamous Cell Carcinoma of left medial ankle. Wide local excision was done followed by radiotherapy. His condition was complicated by local recurrence into the medial malleolus requiring resection of the distal tibia resulting in a bone defect of 9 cm. Fusion of ankle was then done with NVFBG. Union was achieved after 28 weeks.

Case 3

9 years old, girl was diagnosed with osteosarcoma of the proximal right tibia. She received 3 cycles of chemotherapy preoperative followed by surgery and another 3 cycles of chemotherapy post operatively. Wide resection and NVFBG was done with 13cm bone defect. Union was achieved after 24 weeks. However, she developed a stress fracture at the proximal end of the distal implant (plating for the graft site) (Figure 1). Another plate was used to bridge the fracture site and union was achieved after 23 weeks (Figure 2).

Case 4

66 years old, lady presented with right wrist swelling for eight months duration. Xray showed a distal radius lytic lesion. MRI showed an expansile cystic lesion with rim enhancement. Biopsy confirmed the diagnosis of giant cell tumour. Wide resection with NVFBG and wrist fusion was done with bone defect of 7cm. Union was achieved after 15 weeks

Case 5

22 years old, male, chronic smoker, came with right wrist swelling and pain for 2 months. Xray showed an expansile lytic lesion over the distal right radius. MRI was reported as multilobulated expansile cystic mass at distal radius with fluid-fluid level. Tru-cut biopsy was done and HPE came back as giant cell tumour. Wide resection and NVFBG with wrist fusion done to bridge a bone defect with 9 cmtotal length. However, he had not achieved union after 1 year of follow up and he was not keen for further intervention (Figure 3).

Case 6

67 years old, lady with underlying right breast carcinoma who underwent right mastectomy followed by chemotherapy and was currently on letrozole presents with right forearm swelling and pain after 2 years of treatment. Xray showed a pathological fracture midshaft right ulna. She had undergone wide resection of the ulna resulting in a bone defect of 13cm. Plating with NVFBG was done to bridge the bone defect. However, after 1 year of follow up, she succumbed to her disease without sign of union.

4. Case Results

Six patients underwent surgery using a NVFBG following the resection of various bone tumours within the period spanning from 2015 to 2019, aged between 9 to 80 years old, three of the patients being male.

Three patients underwent resection due to giant cell tumour, with one occurring in the tibia and the remaining two located in the radius. Additionally, one patient presented with tibial squamous cell carcinoma, one with tibial osteosarcoma and another with ulna bone metastasis secondary to breast carcinoma.

The defect lengths resulting from the tumour resections varies between 7cm to 16cm with mean of 11.2 cm. In our case series, union was achieved in 4 out of 6 cases. Two cases did not achieve union after 1 year of follow up. The timeframe for achieving union was varied between 15 to 28 weeks with median time of 24 weeks.

One patient had a stress fracture over the proximal end of the distal graft-host junction plate requiring removal of plate and replating was done, achieving union by 23 weeks.

Table 1: Patient Details

Patient	Sex	Age	Diagnosis	Site	Defect length
1	Male	27	Giant Cell Tumour	Tibia	16cm
2	Male	80	Squamous Cell Carcinoma	Tibia	9cm
3	Female	9	Osteosarcoma	Tibia	13cm
4	Male	66	Giant Cell Tumour	Radius	7cm
5	Male	22	Giant Cell Tumour	Radius	9cm
6	Female	67	Bone Metastases	Ulna	13cm

Table 2: Patient Outcomes

Patient	Union	Time to Union	Complication
1	Yes	24 weeks	No
2	Yes	28 weeks	No
3	Yes	24 weeks	Stress fracture
4	Yes	15 weeks	No
5	No	N/A	No
6	No	N/A	No

Figure 1: Case 3 had stress fracture post union

Figure 2: Case 3-post removal of plate and replating

Figure 3: Case 5 with non-union of graft

5. Discussion

The utilization of NVFBG in orthopaedic procedures was widely used in the management of bone defects after bone tumour resection. The integration process of NVFBG involves creeping substitution, characterized by the gradual infiltration of recipient tissue into the graft's surface. Findings from studies, such as Anders et al., bone scintigraphy showed active fluorochrome uptake in the periosteum, underscoring its viability over bone structures, indicated by the contrasting negligible uptake in bone marrow and cortical bone [4].

Union rates, as observed by Enneking et al. showed a primary union of NVFBG at 63% within 12 months, similar to Yadav et al. reported percentage of 60% within 8 to 10 months [5]-[6]. In contrast, Krieg et al. documented a notably higher primary union rate of 89% within 12 months, underscoring the variability in union duration without establishing a direct correlation to graft length [3]. In our study our union rate was 66% and our median time for union was 24 weeks. One patient was a chronic smoker and another patient had reactivation of her disease.

In the context of blood supply within grafts, the choice between vascularized and non-vascularized grafts hinges upon the transfer of blood supply with the bone. However, achieving consensus on the superior graft type for reconstruction remains an enigma. Allsopp et al reported that vascularized grafts might have higher complication risks without yielding notable improvements in union rates or hastening the union process [2]. In contrast, Schuh et al favoured NVFBGs due to their cost-effectiveness, quicker surgery, and procedural simplicity [7].

It was generally accepted that vascularised fibula bone graft was preferred for defects more than 6 cm over NVFBG [1]. However, there were a few studies showing that NVFBG can be used for bone defects more than 12cm [2][3][9]. There was no advantage regarding union even if the defect was more than 12cm.

Stress fractures after union was noted to be one of the complications following NVFBG and was reported to be as high as 9-15% particularly associated with graft lengths surpassing 12 cm [7]-[9]. Notably, stress fracture usually manifests in NVFBG that have already achieved union. In our series one patient had a stress fracture after union was achieved.

In regards to donor site morbidity, various complications, including peroneal injury, compartment syndrome, and ankle instability, were reported at rates spanning from 4to 16% [4]. Multiple strategies have been proposed to mitigate such complications, such as preserving a segment of the fibula (4 cm proximal and 6-8 cm distal) to alleviate the risk of ankle instability [9].It has also been reported that vascularized fibular graft has higher rates of complications compared to NVFBG [7].

In summary, integration of NVFBG relies on creeping substitution which is primarily reliant on periosteal viability. Union rates display variability across studies without establishing a direct correlation with graft length. Stress fractures do pose concerns, predominantly in longer grafts, while donor site morbidity underscores the importance of meticulous surgical techniques to mitigate complications. Further research exploring optimal graft length, comprehending biomechanical stress, and refining surgical approaches holds promise in enhancing the efficacy and safety of NVFBG procedures in orthopaedic surgeries.

Our study was limited by a small number and heterogenous of cases in our case series limiting statistical analysis.

6. Conclusion

The use of non-vascularised fibular autograft for the reconstruction of tumours is an effective surgical technique in addressing large bone defects post tumour resection.

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Author Profile

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