European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 9, Issue 3, Winter 2022

ORIGINAL RESEARCH

The treatment of benign lesions of the proximal femur with non-vascularised autologous fibular strut grafts

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ABSTRACT

Introduction: The relative use of the non-vascularised fibula grafts was recommended as the gold standard for the biological reconstructions has been in practice for more than 60 years. The aim and objective of this retrospective study was primarily focussed to analyse the results with regard to variables such as consolidation, hypertrophy at the graft-host junctions and presence of certain complications as well as to assess the functional and oncological outcomes.

Materials and Methodology: Fifteen patients reported with primary benign tumours involving the proximal femur includes the femoral neck were treated surgically at the department of orthopaedics, IGIMS Patna between October 2019 and March 2021. There were ten males and five females. Their average age at the time of presentation was 34 years (21–68) and the average follow-up time was considered up to 12 months.

Results: Intraoperative blood transfusion was required in eight patients (53%; autologous blood transfusion in five, blood component transfusion in three).There was no significant difference in the duration of restriction of full weight-bearing between the patients who were treated with CPC and CHA (p = 0.52, Mann-Whitney U test). All patients had equally regained full physical function without the development of pain in the final follow-up period.

Conclusion: To conclude, it has been suggested that the management of the bone lesions involving the proximal femur with the use of compression hip screw and synthetic bone graft is considered as relatively safe and effective method.

Keywords: benign tumour, proximal femur, non-vascularised grafts, autologous,

INTRODUCTION

The best management method has still remains unclear and vague since the bone tumours involving the meta-diaphyseal region of long bones are relatively rare (less than 10%) and the reconstruction of emerging bone defects (segmental or hemi-cortical) are reported to be challenging.[1,2]Due to their ease of availability, increased cost effectiveness and rapid recovery rate, this modular intercalary tumour endoprostheses are most commonly used but the complication rates which were reported from these endoprostheses are quite high sometimes.[2,3]Hence, considering the number of patients with malignant primary bone tumours have been relatively cured due to the interdisciplinary treatment strategies, biological reconstructions should therefore be applied if possible. Therefore, more number of specialists might agree that biological reconstructions should especially be used in patients with stage I and stage II tumours so that in patients with advanced primary bone tumours (stage III) or

secondary lesions (metastasis)—in which relative early full weight bearing portion and functionality are the two major concerns when compared to their durability.[4,5]Based on the localization, size of the defect and shape (segmental/hemi-cortical), underlying entities and supplement treatment modalities, biological reconstruction protocols that include massive or hemi-cortical allografts (with or without vascularised autografts),[6–8]distraction osteogenesis,[9] replantation of the sterilized lesion -bearing bone segment (e.g. after extracorporeal irradiation),[10] the membrane induced technique[11] or the use of vascularised or non-vascularised bone grafts.[1,12,13]

At the beginning of the twentieth century, the relative use of the non-vascularised fibula grafts was recommended as the gold standard for the biological reconstructions for more than 60 years. There are various advantages of this method when compared to the use of vascularised autografts comprised of the remodelling capacity at the donor site, easier operative technique and a relative shorter operative time.[13,14]Therefore, majority of the non-vascularised fibula grafts are thought to lack few biological activity and have relative high risk of resorption, vascularised fibula grafts have been reported more frequently applied for the reconstruction of the defect during the last fourdecades.[1,12,15]So far, there are quite a few reports on the defect reconstructions even after bone tumour resection using non-vascularised fibulae grafts but most of these studies might not focus on the extremities or might seem a rather small cohort of patients.[13,16] The aim and objective of this retrospective study was primarily focussed to analyse the results with regard to variables such as consolidation, hypertrophy at the graft-host junctions and presence of certain complications as well as to assess the functional and oncological outcomes.

MATERIALS AND METHODOLOGY

Eighteen patients with primary benign bone tumours or tumour like conditions of the proximal femur which include the femoral neck were treated surgically at the department of orthopaedics, IGIMS Patna between October 2019 and March 2021as tabulated in table 1. Out of these 18 patients, three lesions were managed with curettage which is followed by the implantation of calcium phosphate cement (CPC) (BIOPEX-R; HOYA Techno surgical Corporation, Tokyo, Japan). Further reinforcement using a compression hip screw was not performed in those three cases because one tumour encroached a major part of the femoral head and two other tumours comprised less than 50% of the diameter of the femoral neck.[17,18] Hence, the remaining 15 patients were possibly analysed. There were ten males and five females. Their average age at the time of presentation was 34 years (21–68) and the average follow-up time was considered up to12 months (6 - 17). The pathological diagnosis was observed to be fibrous dysplasia in seven patients, simple bone cyst in four, giant cell tumour in three and chondroblastoma in one. The various indications that were required for the surgical management were those tumours with impending pathological fracture, tumours causing repeated and recurrent pain and tumours with a putative expansive natural course. The 15 patients were managed with the curettage which is followed by implantation of CPC and/or calcium hydroxyapatite ceramic (CHA) granules (BONECERAM; Olympus Corporation, Tokyo, Japan) in combination with reinforcement using a compression hip screw. These synthetic bone substitutes could eventually be selected based on the size of cavity. Moreover, CHA was applied to the tumours which had a potential risk of leaking outside of bone if CPC was used in the surgical management.

RESULTS

The average intra-operative loss of blood was estimated to be 1089 mL (48 – 3198) and intraoperative blood transfusion was required in eight patients (53%; autologous blood transfusion in five, bloodcomponent transfusion in three). The average operative time was

ranged between 169 minutes (64–257). All patients were equally required between 2 week and 50 weeks after the surgery before full weight bearing was permitted. There was no significant difference in the duration of restriction of full weight-bearing between the patients who were treated with CPC and CHA (p = 0.52, Mann-Whitney U test). All patients had equally regained full physical function without the development of pain in the final follow-up period. None of the patients reported with pain at the time of operation site at the time of review. No toxicity was detected in regular haematological tests. No patients sustained a pathological fracture of the femur following the procedure. All patients equally achieved partial or complete radiographic consolidation of the lesion within 1 year. Post-operative superficial wound infection was observed in one patient who almost resolved with intravenous antibiotics. Chronic hip pain was reported in one patient due to the irritation for tensor fascia lata muscle by the tube plate.

Table 1: Patient characteristics

Case	Age/gender	Diagnosis	Location of the tumour			Surgical position
			Head	Neck	Trochanter	
1	22/F	FD	No	Yes	No	Supine
2	28/M	FD	No	Yes	No	Supine
3	43/M	FD	Yes	Yes	Yes	Supine
4	23/M	GCT	No	Yes	No	Lateral
5	53/M	GCT	Yes	Yes	No	Supine
6	42/M	SBC	No	Yes	Yes	Supine
7	27/M	FD	No	Yes	No	Supine
8	24/F	CB	No	Yes	Yes	Lateral
9	31/M	FD	No	Yes	No	Supine
10	31/M	GCT	No	Yes	Yes	Supine
11	43/F	SBC	Yes	Yes	No	Supine
12	28/M	SBC	No	Yes	No	Supine
13	68/F	FD	No	Yes	Yes	Lateral
14	29/F	SBC	No	Yes	No	Supine
15	31/M	FD	No	Yes	Yes	Supine

FD - Fibrous dysplasia; GCT - Giant cell tumour, CB - Chondroblastoma; SBC - Simple bone cyst

Table 2: Clinical outcome in 15 patients

Case	Bleeding (mL)	Operative time (min)	Implantation	Reinforcer	Time to FWB	Event	Follow – up (months)
1	782	159	CHA	CHS	8 weeks	Removal of CHS	12
2	1601	257	CHA	CHS	4 weeks		8
3	582	129	CHA	CHS	1 week		6
4	3200	172	CPC	CHS	13 weeks	Local recurrence	12
5	218	137	CHA/CPC	CHS	9 weeks		11
6	1624	162	CHA	CHS	4 weeks	s/c infection	9
7	2700	160	CPC	CHS	3		5

					weeks		
8	446	162	CPC	CHS	3 weeks		12
9	990	235	CPC	CHS	1 week		7
10	602	167	CPC	CHS	4 weeks		8
11	1185	202	CHA/CPC	CHS	1 week		8
12	184	159	CHA	CHS	4 weeks	Removal of CHS	12
13	46	127	CPC	CHS	2 weeks		10
14	252	131	CHA	CHS	1 week		5
15	1724	146	CHA/CPC	CHS	3 weeks		9

CHA - Calcium hydroxyapatite ceramic; CPC - Calcium phosphate cement; CHS - Compression hip screw; s/c - subcutaneous; FWB - Full weight-bearing.

DISCUSSION

In this current study, it has shown that the clinical outcomes of the surgical treatment procedure for the proximal femoral benign bone tumour using a compression hip screw and synthetic bone graft. Few authors might recommend the surgical reinforcement of the proximal femur after the resection of bone tumour in order to prevent the postoperative pathological fracture when the tumour tends to affect more than 50% of the diameter of the femoral neck or affects at least 50% of the bone cortex of the femoral neck.[17,18] Hence, we applied these criteria to compile the indications of compression hip screw. *Shih* et al[19]observed that the results of 35 patients reported with benign bone tumours of the femoral neck or greater trochanter area, where the bone defect was equally reconstructed with allogeneic cortical strut, autologous cancellous bone graft and compression hip screw via lateral approach. They reported with no postoperative tumour recurrence and no complications were seen in any of the patient. In this study, we tend to use synthetic bone graft instead of allogeneic strut due to the fact that the allograft has a potential for the transmission of infectious disease.[20-22]Moreover, there is no commercially available supply of allogeneic bone grafts or substitutes.*George* et al[23]inferred that the results of the treatment for 17 benign lesions of the proximal femur with non-vascularised autologous fibular strut grafts through lateral approach. They resulted that there was postoperative tumour recurrence in almost two patients and no postoperative pathological fracture were reported inany patients. Autologous bone graft has been considered to be the ideal bone substitute and its disadvantages include limited availability, the risk of tumour implantation into the donor site and the reported undesirable effects at the donor site like nerve injury, bleeding, fracture and infection.

Calcium hydroxyapatite ceramic (CHA) has been effectively used in the field of orthopaedics[24] during the last two decades. Immediately after surgery, there is no observable difference in the mechanical strength between the bone which is being filled with bone substitute and the bone which is left empty. Therefore, a bone substitute could eventually act as a scaffold for the new bone formation; bone filled with substitute could gradually become stronger against various mechanical stresses than a bone defect which is left empty. The calcium phosphate cement (CPC) which is used in this study is an inject able biocompatible bone substitute which has been applied for various applications in orthopaedic surgery because of its attractive mixing, manageability and biological properties. CPC relatively offered a useful bone substitute for the management of bone and soft tissue tumours.[25] The

compressive strength of the cured materials is reported to be around 65 MPa by 3 days after mixing, reaching a final strength of more than 70 MPa by 1 week after mixing.[26,27] Therefore these synthetic bone substitutes should be selected based on the size of cavity. Hence, we believe that full weight-bearing could be permitted within a few weeks in those patients who were managed with CPC in combination with compression hip screw, even if there is large cavity at the trochanteric and femoral neck lesions after the insertion of lag screw. In eleven (73.3%) out of 15 patients with a compression hip screw, full weight-bearing was allowed within 4 weeks and there was no reported postoperative fracture. This duration of restriction of weight-bearing in our study participants were relatively shorter in previous reports (*Shin* et al,[19] six weeks; *George* et al,[23] 14 weeks). Moreover, it has been suggested that meticulous care should be taken when allowing early full weight-bearing in patients with tumours within the femoral head due to the potential risk of cut-out of the lag screw.

Some researchers have reported that the anterior approach has an added advantage of local tumour control.[28] they postulated that this approach permits total curettage and exposure of the femoral neck and articular cartilage of the distal femoral head without dislocation. Therefore, the lateral approach did not intend to cause an increased rate of local recurrence in this current study. The anterior approach has an added advantage for the tumour which is localized in femoral head since the curettage through the lateral femoral window is cumbersome due to a long distance to femoral head. Alternatively, the anterior approach has an increased potential risk of the injury to the lateral circumflex femoral artery which could eventually leads to postoperative femoral head necrosis. Also, the anterior approach might result in an unexpected amputation due to the development of contamination around femoral artery when the postoperative histological diagnosis was diagnosed as malignant bone tumour. Hence it has been preferred that the lateral approach for the curettage of proximal femoral bone tumour has been relatively followed in the study.

CONCLUSION

To conclude, it has been suggested that the management of the bone lesions involving the proximal femur with the use of compression hip screw and synthetic bone graft is considered as relatively safe and effective method.

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