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Title: Proximal femoral osteochondroma excision aided by computer navigation; surgical technique and case series

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Level of Evidence: IV

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Abstract:

Background:

Osteochondromata are common benign bone tumors that occur as solitary tumors as well as in the setting of multiple hereditary exostoses (MHE). Osteochondromata of the proximal femur can frequently be symptomatic and may present with pain, impingement<sup>1,2</sup>, and sciatica secondary to nerve compression<sup>3,4</sup>. Certain issues are commonly faced in the resection of these tumors of the proximal femur, namely; 1) vital structures are in close proximity 2) obtaining adequate exposure can be challenging and 3) prophylactic fixation is frequently indicated owing to the potential for the iatrogenic trauma of resection affecting the structural integrity.

The utility of computer-navigation in the field of orthopaedic oncology<sup>5</sup> has been demonstrated to provide additional confirmation when operating in relatively poorly accessible anatomical sites, to guide the performance of complex 3-dimensional osteotomies, and to facilitate precision in performing osteotomies.

Questions/Purposes:

The use of computer-navigation was hypothesized to be able to aid surgeons to achieve the dual goals of adequate tumor removal and preservation of native bone stock in patients undergoing osteochondroma resection in the proximal femur.

The purpose of this study was to evaluate our institution's experience with the use of computer-navigation to aid proximal femoral osteochondroma resection with particular focus on complications and post-operative functional scoring of patients.

Patients and Methods:

This case series is a study of seven patients who underwent computer-navigation aided excision of proximal femoral osteochondromata at our institution over a 30 month period. Only patients with a minimum of 6 months of follow-up were included. The mean age of these seven patients was 25.4 years (Range: 18-38 years) and the group comprised three males and four females. Mean follow-up was 13.1 months (Range: 7 - 27 months). Pre-operative workup included radiographs and computed tomography. Patients were followed up at 3, 6, 12, 18, and 24 months with radiographic imaging as well as scoring of the Musculoskeletal Tumor Society (MSTS) score. Patients were permitted partial-weight-bearing ambulation in the immediate post-operative period, with full weight bearing after the first month.

A commercially available navigation software system was used for pre-operative planning, and for intra-

operative computer navigation. For each patient, a gender and size matched normal proximal femur was identified from the institution's image database. Specifically the parameters matched were femoral head diameter, femur neck diameter, proximal femur diaphyseal diameter, and femoral neck angle. Computerized tomography images of the patient and the normal femur were fused on the navigation planning software. The intended resection margins were then plotted on the patient's proximal femur using the normal proximal femur as a template. This means of templating was intended to maximize bone preservation.

#### Results:

Five of the seven patients treated had isolated exostoses, while the other two patients had tumors in association with multiple hereditary exostoses.

A posterolateral approach was employed for the three patients with tumors projecting posteriorly or posteromedially, while an anterior (Smith-Petersen) approach was used for the four patients with anteriorly and medially based tumors. Prophylactic fixation was performed using a separate approach in these four patients that required anterior approaches.

No intra-operative fractures were occurred. No post-operative complications occurred, and no unplanned secondary procedures were required any of the patients in this study. All patients were satisfied with the results of the surgery with the mean MSTS scores at last follow up being 28.8 (Range:27-30).

#### Conclusions:

This series is the first report of this novel application of computer-navigation, and demonstrates favorable post-operative functional scores as well as a low complication rate.

While small, this series demonstrates the applicability, safety and efficacy of computer-navigation in resection of these tumors. A particular advantage for this technique was noted in resections involving particularly large tumors that obscured anatomical landmarks and in patients with MHE with associated proximal femoral deformity. This study is limited by its small size, which is due to this protocol of pre-operative templating and intra-operative navigation being implemented relatively recently in our institution and the very specific indications for surgical intervention in this condition.

#### References

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Table 1: Summary of patient details

Case	Age	Sex	Side	MHE?	Site of tumor		Approach	Prophylactic fixation	Complications	Follow-up (mths)	MSTS score
1	38	M	L	No	Posteromedial	Femoral neck	Posterolateral	None	None	27	30
2	25	F	L	No	Medial	Subtrochanteric	Anterior	Nail	None	17	27
3	29	M	L	No	Posteromedial	Femoral neck	Posterolateral	None	None	12	28
4	25	F	L	No	Posterior	Femoral neck	Posterolateral	None	None	12	30
5	18	M	L	Yes	Anteromedial	Intertrochanteric (IT)	Anterior	DHS	None	9	28
6	19	F	R	No	Medial	Femoral neck/IT	Anterior	DHS	None	8	30
7	24	F	L	Yes	Anterior	Femoral neck /IT	Anterior	DHS	None	7	27

Figure 1:

A: AP Pelvis xray of patient '6', B: Computer screenshot during intra-operative navigation depicting axial CT image, coronal and sagittal reconstructions. Pre-operative plan for osteotomy marked in magenta, Green line depicting navigation stylus, Yellow circles depicting extent of tumor as plotted pre-operatively.

