"Rotationplasty" A Modified Amputation Surgery: A Beauty in the Eyes of Almighty

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Bone tumors constitutes around one percent of all malignant tumors and osteosarcoma and Ewing's sarcoma are observed in paediatric age group. The recent advances in imaging modalities, chemotherapy and surgical techniques have improved the chances of limb salvage surgery in majority of patients with malignant bone tumors. Amputation still plays important role in surgical management of malignant bone tumors. In young children with malignant bone tumor that require knee or hip resection; surgical treatment options includes reconstruction with an expandable megaprosthesis or amputation or modified amputation (rotationplasty).[1-4]

Despite expandable megaprosthesis provides good functional outcome it has its own limitation including limited availability of implant, costlier implant and repeated surgeries for limb lengthening.[4] Rotationplasty is a modified amputation surgery in which the ankle joint is converted into the knee joint following resection of the tumor and an 180 degree external rotation of the limb.[1,2] Rotationplasty is an excellent alternative procedure to amputation surgery in patients with malignant bone tumours of the femur and proximal tibia. The reversed or rotated ankle joint (modified "knee joint") is surgically placed at the level of the expected contralateral knee joint after growth completion, avoiding the need for revision surgery and lengthening.[4] Rotationplasty can also be used as a treatment modality in the management of congenital limb discrepancy, infected implant surgery and severe limb length discrepancy following trauma. This procedure converts high above amputation or hip disarticulation surgery into below knee amputation leading to an energy saving and better bio-mechanical procedure.[4] The important advantage of rotationplasty is patient experiences no phantom limb pain because the sole is the weight bearing area.

History of Rotationplasty (Table 1)

The rotationplasty surgery was popularized by Van Nes in 1927 and was performed mainly for congenital defects around knee joint.

Table 1: History of Rotationplasty

Author	Year	Contribution
Borggreve	1927	Performed rotationplasty for a patient with a fused knee joint and limb-length discrepancy due to tuberculosis
Van Nes	1927	Popularized this procedure in Congenital defect of Knee joint
Knahr and Salzer	1975	Alternative technique to above knee amputation in osteosarcoma of the distal femur
Winkelmann	1986	Classification of rotationplasty for malignant tumors of the proximal femur with or without involvement of the hip as well as of the lower pelvis

Table 2: Winkelmann classification of rotationplasty: Type A

Knee Rotationplasty (Type A)	Type A I	Type A II
	Tumors around Distal Femur	Tumors around Proximal Tibia

Table 3 : Winkelmann classification of rotationplasty: Type B

Knee Rotationplasty (Type B)	Type BT I	Type B II	Type B III
	Tumors around Proximal Femur without Hip joint involvement	Tumors around Proximal Tibia with involvement of lower pelvis	Tumors of complete Femur Type III a : Children Type III b: Adults

Classification

Modified Winkelmann classification of rotationplasty based on the level of tumor involvement.

Winkelmann classification of rotationplasty: Type A (Knee rotationplasty) and Type B (Hip rotationplasty).(Table 1, 2)

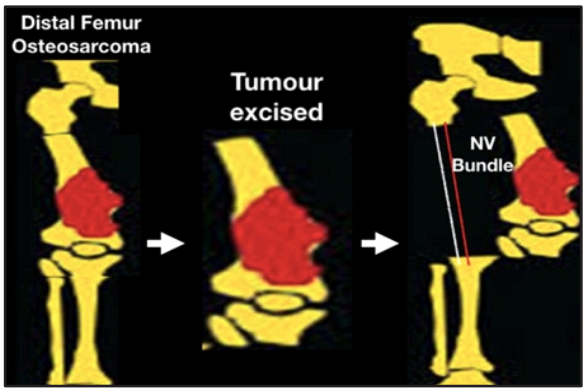

Figure 1: Key steps of rotationplasty in schematic format: Showing a osteosarcoma of distal femur, wide resection of tumor and isolation of neurovascular bundle

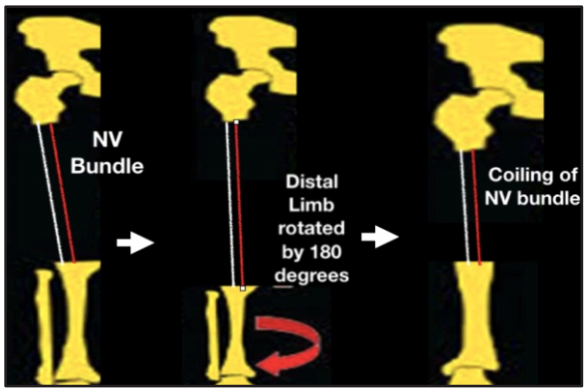

Figure 2: Key steps of rotationplasty in schematic format: Isolated neurovascular bundle, rotation of distal leg by 180 degrees and coiling of neurovascular bundle

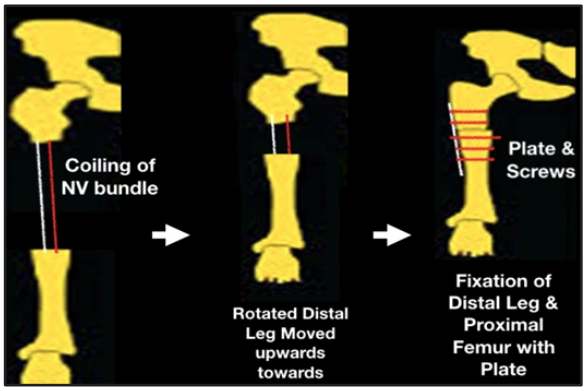

Figure 3: Key steps of rotationplasty in schematic format: Rotated leg is moved upwards and proximal femur is fixed with proximal tibia with help of a plate and screws

Figure 4: Plain radiograph of 9 year boy with osteosarcoma tibia, skin incision marked for rotationplasty and isolated neurovascular bundle following wide resection of tumor

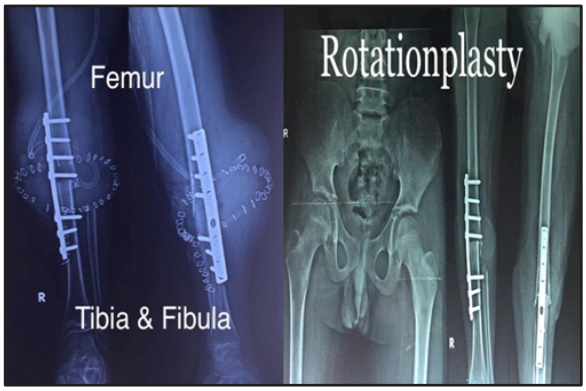

Figure 5: Immediate and follow-up radiograph of patient following rotationplasty surgery

Figure 6: Summary of rotationplasty with functional outcome of patient

Indications and Contraindications for Rotationplasty

The indications for rotationplasty includes
A sensate foot with functional ankle range of motion and adequate plantar flexion strength is prerequisite for a functional rotationplasty

- Primary bone tumors in paediatric age group involving femur bone or proximal tibia bone requiring reconstruction with expandable megaprosthesis: Expected growth of ipsilateral normal leg of more than 10 cm,
- Adult patients with bone tumors requiring hip disarticulation or high above knee amputation,
- Non oncologic indications: severe congenital limb discrepancy, infected implant surgery, non-reconstructive large bone defects following trauma.

The contraindications includes

- Patients with large size tumors in which sciatic nerve and common perineal nerve can't be saved with good oncologic margins,
- Tumor involving foot and ankle joint,
- Non willing patients for surgery and medially unfit for anesthesia.

Preoperative planning

- Preoperative work-up consist of plain radiograph of the affected extremity and a scannograph of both lower limb,
- MRI of the affected bone: Whole bone is screened and planning is done for the surgical resection of tumor, decide level of osteotomy and status of sciatic nerve and neuro-vascular bundle,
- Metastatic work-up: CT thorax, Bone scan and PET CT scan,
- Paediatric patients: The anticipated growth of the opposite leg is calculated: Contribution to growth by proximal femur, distal femur, proximal tibia and distal tibia. The ankle joint (new knee joint) following rotation pasty will be at different level.
- A growth calculator formula: Mosely's graph: Straight line graph can be used to estimate the leg length growth and the appropriate length of leg is calculated.

Key Surgical Steps (Figures 2 - 5)

- The skin incision are planned according to the prior biopsy scar and the affected skin are excised along with the resected specimen.
- The incision in the affected area are rhomboid shape or circular shape and the incision should be mirror image of planned distal limb.
- The sciatic nerve and its branches common peroneal nerve and posterior tibia nerve are dissected and separated from the tumor with oncological safe margin.
- The femoral vessels and popliteal vessels are dissected and separated from the tumor with oncological safe margin.
- The proximal osteotomy of femur bone or resection of femoral head is planned according to extent of bone sarcoma.
- The distal osteotomy or proximal tibia length are planned according to preoperative planning of anticipated growth of opposite leg.
- Neurovascular bundle are coiled.
- Type A rotationplasty: Fixation between proximal femur and tibia are performed with help of plate or intra-medullary nail after rotating the leg by 180 degrees.
- Type B: Distal femur or proximal tibia are placed in acetabulum after rotating the leg by 180 degrees.
- In cases with vascular involvement by tumor: resection of vessels and anatomizes are performed
- **Post operative radiograph:** To assess the bone union between osteotomy sites.

Complications

The early complications of rotationplasty includes neurovascular injury, thrombosis of artery and vein leading to amputation of the affected limb. Other complications includes altered wound healing which includes skin loss, flap necrosis and wound infection. The complications seen seen in later period includes nonunion, mal-union, limb length discrepancy and local tumor recurrence.

Recent advances about Rotationplasty

- In cases of vascular affection by the bone tumor; vascular anastomosis of artery and vein can be performed by a multidisciplinary team.
- Use of free flap and nerve repair can be doe in cases with soft tissue defect and nerve defects, respectively.
- The use of rotationplasty principle can be extrapolated and used in tumors around elbow joint to preserve hand function.

Conclusion

Management of bone tumors in pediatric patient is a great challenge to the clinicians. It would be optimal to say about Rotationplasty that **'Beauty in the eye of Almighty'**; it provides good function despite the limb it provides doesn't look cosmetic(Figure 6). Rotationplasty is an excellent surgical procedure that provides an optimal functional outcome in pediatric patients with malignant bone tumors. This surgery provides a permanent below knee amputation stump over which an artificial prosthesis is applied and provides unaided bipedal ambulation. Relatives of patient must be counselled about rotationplasty surgical steps and postoperative outcomes with its photos and videos. A good patient selection is important to achieve better functional outcomes following rotationplasty.

References

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