Challenges in limb reconstruction in young kids

Said Saghieh, MD
Associate Professor of Orthopedic Surgery
AUB-MC
www.bonedeformity.com
Young Kid

- 7 year-old girl
Young Kid

- Articular cartilage

- Growth plate
  - Proximal
  - Distal
Young Kid

Margins?
Young Kid

- Two stages?
Young Kid

- Biologic reconstruction
  - Free fibula graft

- Problems?
  - Non Union
  - Small diameter bone
  - LLD
Young Kid

- Non Union
Young Kid

- Limb Length Discrepancy
  - Surgery
  - GP affected
- Malalignment
- Joint Contracture
  - Knee in extension
  - Ankle Equinus
  - Contralateral knee in flexion
Goals

- Introduce Limb Salvage Program
- Problems in young kids
- Experience of CCCL
- Future Directions
CCCL

- Children Cancer Center of Lebanon
- AUB-MC affiliated with St Jude-Memphis
- 2002
- Pediatric Oncology (up to 18y)
- Free care: the most successful fund raising continuous campaign
- Lebanon, Syria, Irak, Jordan, Gulf
Limb Salvage Program

- 2 orthopedic surgeons
- 1 pediatric general surgeon
- 5 oncologists
- 1 radiologist
- 2 radiation therapist
Limb Salvage Program

- Clinical experience previously reported
- 8-12 / year

Haidar et al, Pediatric Blood & Cancer; 2008
Limb Salvage Program

- Diagnosis
  - FNA/Core biopsy*
- Complete evaluation, staging
- Neoadjuvant Chemotherapy

Multidisciplinary Approach
Limb Salvage Program

- Surgical planning
  - Identify the neurovascular structures
  - Length of resection
  - Order prosthesis or allograft

- Repeat MRI before local control
Limb Salvage Program

- **Surgery**
  - Wide resection
  - Preserve Limb Function
    - SFVx, Popliteal Vx, PTVx
    - Sciatic, PT, CPN +/-, S/DPN-
Limb Salvage Program

- Reconstruction
  - Prosthesis
  - Allograft
  - Others

- Postoperative chemotherapy
Limb Salvage Program

- Contraindications:
  - Absolute: rare
Problem: Very Young Kids

- Leg Length Discrepancy
  - Involvement of one growth plate
  - Prosthetic reconstruction may damage the adjacent one
  - # 1.5 cm /year (6-9 cm in 10 year-old kid)

- Survival of the prosthesis
Case-Scenario

- Osteosarcoma distal femur at the age of 7
- LSS with prosthesis in UK
- LLD=11cm
- Femur lengthening
- Tibia Lengthening
- Deep infection
Prosthesis removal
Cement Spacer = 12 cm
Multiple debridement
Persistence of draining sinus
LLD = 8 cm
LLD

- Debridement
- Medial transfer of the fibula for arthrodesis
- Distal tibia lengthening
LLD in Very Young Kids

- Solutions:
  - Intraoperative Lengthening
  - Epiphysiodesis
  - Expandable Prosthesis
Expandable Prosthesis

- Old generation
- Semi-invasive
- Non-invasive
Expandable Prosthesis
Non-invasive

- Phenix (Arnaud Soubeiran)
- Repiphysis, Wright Medical
Expandable Prosthesis
Non-invasive

- The expandable portion of the device consists of a titanium tube (A) that ‘telescopes’ within an outer body made of poly-ether ether ketone (B).
- A spring (S) compressed between the two closed cylinders (A and B) stores energy relative to its length, diameter, and cubic thickness.
Expandable Prosthesis Non-invasive

- With the child under light sedation, the locking mechanism on the prosthesis is identified with fluoroscopy.
- The electromagnetic coil is then placed over the patient's leg at the level of the locking mechanism and is activated for few seconds.
Expandable Prosthesis
Non-invasive

This heats a ferrite element in the prosthesis, which heats and softens a small segment of polyethylene, which subsequently allows controlled expansion of the spring.
Expandable Prosthesis
Non-invasive

- Lengthen on the side of the resection
Expandable Prosthesis Non-invasive

- Allow the growth on the adjacent side

CCCL experience

- 18 patients (28 pts in 2016)
  - Distal femur: 11
  - Proximal tibia: 7

CCCL experience
First 12 patients (2002-2007)

- 54 lengthenings (9mm/lengthening)
- 5 patients passed away; all were stage III.
- 7 patients achieved skeletal maturity:
  - 5 equal LL (two converted to modular prosthesis, one converted to TFR, three are waiting because of fracture of the spring)
  - One needed another repiphysis and ended with LLD
  - One patient had severe infection. Prosthesis removed.
CCCL experience
First 12 patients / Complications

- Deep infection: three
  - One Xchanged to modular
  - One reinsertion of repiphysis
  - One refused further surgery for 3 years then converted to Ilizarov fusion
CCCL experience
First 12 patients / Complications

- Stem fracture / loosening:
  - 3 patients
  - revised
CCCL experience
First 12 patients

- Failure of Expansion:
  - Short unsupported stem?
  - Delay in starting
CCCL experience
First 12 patients

- Breakage of the Spring:
  - Before or after achieving equal LL
CCCL experience
First 12 patients

- Need more expansion:
  - Plan your resection
    - More bone resection will allow more lengthening potential
  - Adequate Monitoring of successive lengthenings
  - Provide patient with ‘carnet’
CCCL experience
2007-2009

- 6 patients
- 24 lengthenings
- No deep infection
- No stem loosening
- No failure of expansion
- No spring breakage
CCCL experience 2007-2009

- One passed away
- One had fracture below tibia stem
- Two were converted to modular
CCCL experience
Learned Lessons

1- Good planning
   ◦ Estimate the growth potential
   ◦ Estimate the LLD at maturity
   ◦ Incorporate this amount of needed lengthening in the prosthesis
   ◦ Do your resection accordingly
What if tumor regressed on chemotherapy?
  • Prosthesis needs to be preordered
  • Cant play with the resection level

Plan for 2 cm osseous margins
CCCL experience
Learned Lessons

- 2- Good Soft-tissue Coverage
  - Plan your incision
  - Do separate biopsy site excision if needed
CCCL experience
Learned Lessons

2- Good Soft-tissue Coverage
- Gastrocnemius flap in proximal tibia
- STSG (do not go for primary closure even if it looks feasible)
CCCL experience
Learned Lessons

3- Start your lengthening sessions early
   ◦ Before soft-tissue contracture and the formation of the pseudocapsule
4- Restrict activities
   ◦ Do not allow sports activities
   ◦ Remember these prostheses lack the stability of the regular ones.
   ◦ High rate of loosening
CCCL experience
Learned Lessons

5- Adjunct treatment
- Do not exclude the contalateral epiphysiodesis from your armenterium
- Good options in patients less than 10 years
- Choose the timing
- Only one side of the knee
CCCL experience
Learned Lessons

6- Plan always for X-change at maturity

- Broken spring may shorten the limb by 1.5-2 cm
CCCL experience

- Be aware of the cost of the treatment:
  - Repiphysis= 45000$
Future Directions

- Bioexpandable prosthesis
  - MUTARS-bio (Implantcast, Germany)
  - Arnaud Soubeiran in France

- Epiphysiolyis revisited

Conclusions

- Multidisciplinary Cancer Center is essential
- Reconstruction in young kids is still problematic
- High cost
- Higher complication rate
- Need a very close follow-up
- Learning curve
- Need for future developments