Modern Luque Trolley for the Management of Early-Onset Scoliosis: The First Ten Patients with a New Gliding Implant with Two-year Follow Up

Learning Curve

Andrew Tice¹, Ahmed Aoude², Ron El-Hawary³, Jean Ouellet²

1. University of Ottawa, CHEO
   Ottawa Ontario, Canada

2. McGill University Health Centre & Shriners Hospital,
   Montreal, QC, Canada.

3. Dalhousie University, IWK Health Centre
   Halifax, NS Canada
Disclosures

Direct Conflicts
DepuySynthes Spine: Prior Consultant for the development of New Guided growth implants
No Royalties

AO Foundation: PI international multicenter study Modern Luque Trolley system

Indirect Conflicts
AO Foundation: Institutional Research and Fellowship Support

IMPLANT IS CE marked but is NOT FDA APPROVED
Background

Current Treatment options for EOS: Dual Growing Rods, Rib based distraction, Magnetic Rods achieve spinal growth however they continue to have a high complications rate, a high rate of planned and unplanned surgeries.

16 surgeries later: Iatrogenic Spondylolisthesis
Paraparesis 2nd to Rod Migration

1.5 yr  2.5yr  5 yr  7yr  9yr old
Background

Original Growth guidance construct was Luque Trolley:

Segmental fixation
   Every level
   Sublaminar wires
   Correction relied on Binding Lamina to rod

Non fusion
   Fixation was relying of wire
   Rods would migrate

“Loose” construct
   no solid anchor
   no rotational control
   Significant residual deformity

Many Issues leading to poor outcomes

Spontaneous fusion

Implant failures

Deformity progression

Background

UNLOCKED “telescopic Rod” OFF Label

Background

**Surgical Technique**

*Modern Luque Trolley, a Self-growing Rod Technique*

**Advantages**

1. **Avoiding repetitive surgeries**
   - Institutionalizing the children
   - Repetitive Anesthesia at early age
   - Decrease risk of infection

2. **Avoid overloading** the spine
   - Leading to iatrogenic sagittal deformities

3. **Allow some motion**
   - Minimize law of diminishing return

No distraction purely self guided growth: **6 cm over 7 yrs**

Surgical Technique

Modern Luque Trolley

New Gliding spinal implants & new surgical technique to address specific short comings (complications) of original Luque Trolley

1. Independent though Solid Prox / Distal anchor Fusions
   Four Rod Construct

- Gliding Anchors
- Fix Anchors
- Apical
- Proximal & Distal

Minimize Implant failures
Surgical Technique

Modern Luque Trolley

New Gliding spinal implants & new surgical technique to address specific shortcomings (complications) of original Luque Trolley

1. Independent though Solid Prox / Distal anchor Fusions
   Four Rod Construct

2. Limited Apical fixation
   Gliding Anchors
   Maximal apical translation

3. Limited surgical dissection

Minimize Implant failures
Maximize correction to normalize forces across growth plates
Minimize Autofusion
Surgical Technique

Surgical Exposure: Classic Subperiosteal dissection at the proximal and distal Fixed anchors. Formal Two level Fusion

Trans-muscular dissection for gliding anchors avoiding bone exposure. Minimizing risk of spontaneous fusion. Wiltse type approach.

Dissection:
- Longissimus & Iliocostalis
- Multifidus & Spinalis
Surgical Technique

Apical Gliding screws:
- inserted **transmuscularly** to minimize risk of **auto fusion**
- are kept off the spine to minimize auto fusion
Surgical Technique

Reduction Technique

Two pairs of rod each fixed proximally and distally that overlap at across the apex. Cantilever and Rod derotation maneuvers achieve deformity correction.
Hypothesis

Growth guidance technique using modern spinal implants with an engineer gliding anchor would decrease overall complication rate, planned and unplanned surgery in EOS Patient, while still allowing the spine to grow.

Methodology

Retrospectively study on patients that underwent Modern Luque Trolley Construct with a minimum of 2 year follow up. Clinical & Radiological data as collected, complications, growth T1-T12, T1-S1 reoperations.

Indication

- Skeletally immature < 10 yrs or Open TriRadiate Cart
- Progressive deformity despite failed casting or bracing
- All EOS etiologies
- Expected deformity > 50 degrees
# Results

## Demographics

<table>
<thead>
<tr>
<th>Since 1st January 2015</th>
<th>n = 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trolley cases than 2yr F/U</td>
<td>N = 10</td>
</tr>
<tr>
<td>AGE (range)</td>
<td>8,4 y,m (5+7 - 14+5)</td>
</tr>
<tr>
<td>Gender</td>
<td>5 F, 5 M</td>
</tr>
<tr>
<td>Etiology</td>
<td>2 Idiopathic, 4 Neuromuscular, 4 Syndromic</td>
</tr>
<tr>
<td>Average F/U (range)</td>
<td>28 months (24 – 35)</td>
</tr>
<tr>
<td>Segments Spanned</td>
<td>10 levels (8 – 13)</td>
</tr>
</tbody>
</table>
## Results

### Deformity Correction

<table>
<thead>
<tr>
<th>Preop</th>
<th>Cobb</th>
<th>68° (47°-93°)</th>
<th>% correction</th>
</tr>
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<tbody>
<tr>
<td>Post Op</td>
<td>Cobb</td>
<td>26° (3° - 42°)</td>
<td>61% (90% - 22%)</td>
</tr>
<tr>
<td>Last F/U</td>
<td>Cobb</td>
<td>31° (4°-52°)</td>
<td>55% (92% - 14%)</td>
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Loss of correction: **Av. 2.5 degrees/year**

- 8° /yr ie additional correction
+ 10° /yr ie Cobb progression

Immediate **Cobb Correction** correlate with
implant density / curve flexibility

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8 yr old Functional spastic Diplegic grew 2 cm over two yr.
### Results

#### Growth

<table>
<thead>
<tr>
<th>Ave. growth / years / per vertebra</th>
<th>0.62 mm</th>
<th>(0.1 – 1 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave. T1-T12 spinal height gain post OP</td>
<td>2.9 cm</td>
<td>(1.2 – 4 cm)</td>
</tr>
<tr>
<td>Ave. T1-S1 spinal height gain Post Op</td>
<td>4.4 cm</td>
<td>(1.8 – 5.8 cm)</td>
</tr>
</tbody>
</table>

5 yr. old girl with 50°

1yr

3 yr F/U

8.5 yr old

Overall growth: 65% of Expected Growth

3yr Post Op no revision nor lengthening surgery. The spine has grown 4 cm across the 10 instrumented vertebra representing 114% of expected growth. Demiglio calculation (3.5 yr X 10 vertebral X 1 mm = 35mm)

Courtesy:
Dr Ron Elhawary
## Results

**Poor Outcome: < 50% expected growth**

**3 pt.** – Large Residual deformity > 20° – Curve Progression - poor growth

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| Av. Cobb progression / yrs | 2.3° (-8° - 25°) |
| Av. growth / yr / per vert | 0.62 mm (0.1 – 1 mm) |

7 yr. old girl

58% of expected growth

10.5 yr. old girl
### Results

#### Post Op

- As patient bended forward distal rod was prominent. Revision surgery consisted of adding a set of gliding screw one level distal.

#### Complications

<table>
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<th>Complications</th>
<th>N= 3 in two patients</th>
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<tr>
<td>1 prominent hardware</td>
<td>Revision surgery</td>
</tr>
<tr>
<td>2 Superficial Wound infection</td>
<td>PO antibiotics</td>
</tr>
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![Radiographs showing different views of a spine with hardware and screws.](Image)
Discussion:

Limitation: Obvious short follow up with few patients

Growth guidance:

WORKS BUT IS NOT for all EOS -
It can control curve progression while allowing spinal growth
Decreases / avoid repetitive surgeries / Interventions
Overall growth may be less - 65% of expected
Overall has less complications

Patient Selection is Key
– intervene earlier when curve are still flexible?

Maximal correction provides better growth and less curve regression
THANK YOU
Growth Guidance:

Conceptually to successfully achieve optimal growth guidance:

- normalizing the forces across all the vertebral growth plate. Maximal Deformity correction Apical control is mandatory.

- One wants a semi-constrained system allowing for motion minimizing auto fusion

- No excessive forces applied To minimize junctional iatrogenic kyphosis or implant dislodgement - inherent spinal growth drives length

- Harmonious sagittal plane allowing growth to occur through out the spine