Ergonomics of Microlaryngeal Surgery

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99th Annual Clinical Assembly of the AOCOO-HNS Foundation
OTOLARYNGOLOGISTS REPORT:

- **83%** have musculoskeletal symptoms after MSL
  - Neck, upper back, shoulders, lower back

- **53%** have musculoskeletal symptoms for **48 hours** AFTER MSL
  - Neck, shoulders

Introduction

• MSL is inherently “risky”
  – NIOSH
  – Static, fixed work postures
  – Limb extended

• Goal: think about YOUR posture

Bernard BP, National Institute for Occupational Safety and Health, publication no 97-141; 1997
Ergonomic analysis of microlaryngoscopy
*Laryngoscope 120:297-305, 2010*

- Consensus “most favorable” position for 3 laryngologists

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>OR bed Trendelenburg angle (degrees)</th>
<th>Laryngoscope angle (degrees)</th>
<th>Head of the bed angle (degrees)</th>
<th>Laryngoscope height (cm)</th>
<th>Laryngoscope to surgeon iliac crest (cm)</th>
<th>Microscope focal length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-12</td>
<td>39</td>
<td>26</td>
<td>93</td>
<td>59</td>
<td>367</td>
</tr>
<tr>
<td>2</td>
<td>-11</td>
<td>39</td>
<td>19</td>
<td>90</td>
<td>54</td>
<td>387</td>
</tr>
<tr>
<td>3</td>
<td>-7</td>
<td>46</td>
<td>22</td>
<td>89</td>
<td>60</td>
<td>388</td>
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Surgeon positioning

• Most “comfortable”

• Compared to other “common” positions for microlaryngoscopy
  – Mayo stand support
  – No arm support
# RULA

**rapid upper limb assessment** → risk of MS misuse

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<th>RULA Score</th>
<th>Workplace recommendations</th>
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<tr>
<td>1 – 2</td>
<td>Working under the optimal ergonomic posture with NO risk</td>
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<td>3 – 4</td>
<td>A potential risk of injury from the posture, which should be investigated further and corrected if possible</td>
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<td>Poor posture with increased risk, thus necessitating changes in the near future</td>
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Simulated Microlarngoscopy

Simulated Microlaryngoscopy

Articulated arm support  Mayo stand arm support  No arm support

Simulated Microlaryngoscopy
Standardized OR Conditions

- Articulated arm support
- Mayo stand arm support
- No arm support

- Form-fitting spandex
- 27 reflective markers → bony landmarks
Motion Capture Analysis
High risk v. Low risk

- Mayo/no arm support
- Articulated arm support

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Neck Flexion

- NIOSH – National Institute of Occupational Safety & Health
  - No normative data
  - Recommend no prolonged flexion > 15-20°

- Articulated Arm Supports
  - Flexion 0-10°

- Mayo Stand
  - Flexion >20°
  - At least 2x neck extensor contractile forces
    - Concern for strain and injury

Maximal Force Exerted

Prolonged Posture

Muscle Strain
“Favorable” Ergonomics of MSL

• Conclusions¹
  – Neck flexion 0-10°
  – Laryngoscope ~40 °
  – Shoulders neutral
  – Foot support
  – Arm support (articulated)

  • 38% do NOT use arm support²

¹ Statham MM, Sukits AL, Redfern MS, Smith LJ, Sok JC, Rosen CA. Laryngoscope 2010; 120:297-305
So why do 38% surgeons still NOT use arm supports?
Comparison of Microsuspension Laryngoscopy (MSL) Positions: A Randomized, Prospective Study

*Laryngoscope. 2015 Mar;125(3):649-54*

- Is there a difference in...
  - Risk of musculoskeletal symptoms
    - Pain
  - Muscle activity and fatigue
- “Favorable” v “unfavorable”
### Parameters

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<th>Favorable</th>
<th>Unfavorable</th>
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<td>Scope Angle ($^\circ$)</td>
<td>39.7 (0.5)</td>
<td>59.9 (1.5)</td>
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<tr>
<td>Neck Angle ($^\circ$)</td>
<td>11.7 (2.2)</td>
<td>29.7 (4.7)</td>
</tr>
<tr>
<td>Arm Rests</td>
<td>Yes</td>
<td>No</td>
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Methods

• 18 otolaryngology trainees (PGY2-7)
• MSL simulator
• Simulated MSL surgical task, 15 min
  – Randomly counterbalanced
  – Rest period, 15 min
• sEMG
• Questionnaires
Results – RULA
rapid upper limb assessment—risk of MS misuse

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- Favorable 3.1 ± 0.3
- Unfavorable 3.8 ± 0.5
- p=0.0002

Simple accommodations (laryngoscope, neck) improve ergo positioning, thus decreasing risk of injury

Results – sEMG

Mean EMG amplitude
- Level of muscle activity
  - ↑ muscle units recruited
  - ↑ myoelectric signal
- Lower trap, cervical trap:
  - most increase in average EMG amplitude in UNFAVORABLE

Muscle fatigue
- Increased EMG amplitude + decreased median frequency of muscle firing
- Favorable: 31% muscles “fatigued”
- Unfavorable: 45% muscles “fatigued”
- Most (% participants): Triceps (67%), upper/cerv trap (56%)
Results – Pain Survey

Average pain score (1=no pain, 10=worst pain possible) for dominant side in favorable (■) and unfavorable (□) positions.
Results - Usability

• “Favorable” easier (p<0.0001)
• “Unfavorable” cumbersome (p=0.0006)
• Less confident in “unfavorable” (p<0.0001)
• More likely to use “favorable” (p<0.0001)

• You can tell the difference
• Just need to think about it, then do it.
Conclusion

- Electromyographic evidence of decreased muscle activation and fatigue; less self-reported pain with more “favorable” MLS ergonomic position

- Quantifiable evidence that improved surgeon ergonomics positively impacts muscle activation and pain associated with MSL
Summary

• Ergonomics are important
• Prospective, randomized study shows...

• Simple modifications → big differences
How to accomplish an ergonomically favorable position

- Laryngoscope ~40°
- Neck 0-10° flexion
- Arm support
- Foot support

- Once laryngoscope in...
- Move pt to come to you
Factors

**Fixed**
- Microscope focal length
- Patient anatomy
- Static posture

**Variable**
- Laryngoscope angle
  - Trendelburg
- Bed height
- Chair height
- Eyepieces (articulated)
- Microbreaks
Results - Microbreaks

- $p = 0.0011$
  - Favorable: $0.7 \pm 0.8$
  - Unfavorable: $3.2 \pm 3.0$
- Corraborates data from survey
  - $>30$ min
- Likely subconscious reactions to increased muscle contraction and fatigue
  - Restorative?
Just
Do
It

I won’t make it to the Olympics.
I’ll never make it to the finish line.
It’s impossible.
I can’t get that landing.
I’m not fast enough.
I’ll never go pro.

I’ll never be that good.
I’ll never break a world record.
I’m not strong enough.
I can’t win the gold medal.
I’ll never be able to think.

I can’t make that shot.
That will never happen.