JOHNS HOPKINS UNIVERSITY

# Evaluation of Various Sensing Modalities for Accurate Measurement of Neck Flexion Angle during Ear Surgery

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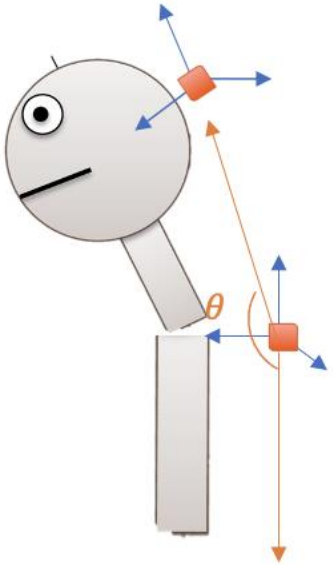
# Project Summary

**Goal:**

Accurate Measurement of Neck Flexion Angle during Ear Surgery by using IMUs (Inertial measurement unit )

Investigate and Compare Postural Ergonomics of Ear Surgeons during Microscopic and Endoscopic Scenarios.




- **Neck Flexion Angle:** extract pitch angle between two IMUs
- **Surgeries:** Analyze neck flexion angle changes in real surgical scenarios

Figure Edit from: https://stanford.edu/class/ee267/lectures/lecture10.pdf

# Paper Selection

Indian J Orthop. 2019 Nov-Dec; 53(6): 758–762. PMCID: PMC6804392
doi: 10.4103/ortho.IJOrtho_677_18 PMID: 31673178

Surgeon's Neck Posture during Spine Surgeries: “The Unrecognised Potential Occupational Hazard”

J Naresh-Babu, Viswanadha Arun-Kumar, and D G S Raju

doi: 10.1016/j.amjoto.2017.01.013. Epub 2017 Jan 19.

**Assessing work-related musculoskeletal symptoms among otolaryngology residents**

Kevin Wong [1], Kenneth M Grundfast [2], Jessica R Levi [3]

Affiliations + expand

PMID: 28129913 DOI: 10.1016/j.amjoto.2017.01.013

- Neck Posture Study
- Insight on data illustration and analysis
- Potential area that our future study can explores

# Paper 1 Background and Method

Purpose: analyze the surgeon's neck postures while performing lumbar spinal surgeries.

Methods to evaluate **spinal posture** have been categorized into four groups:

- Radiography.
- Three-dimensional motion analysis.
- Video raster stereography analysis.
- Photographic posture analysis: Basic objective observational measurement method using anatomical landmarks.

60 videos performed by three spine surgeons
Snapshots of the video were taken whenever the surgeon changes the position by using Surgimap (Spine Software).

# Paper 1 Experiment

- Three reflective markers were taped on the side of the surgeons
- The whole surgery can be divided into different phases: exposure, fixation, decompression, fusion, and closure.

ure 1: Reflective markers taped on side of the surge

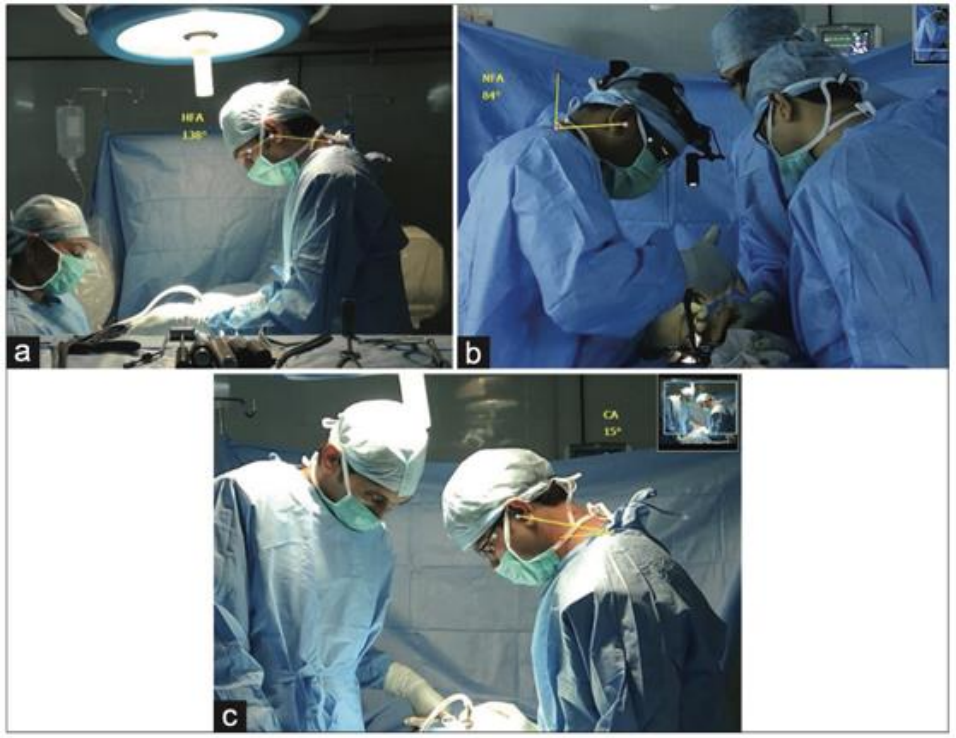



Figure 2: Snapshot pictures showing head flexion angle (a), neck flexion angle (b), and cervical angle (c) of operating surgeons

- Head flexion angle (HFA)
- Neck flexion angle (NFA)
- Cervical angle (CA)
- Lumbar decompression (LD)

# Paper 1 Result Summary

- Decompression and fusion are the most stressful phases affecting surgeon's neck.

**Table 1: Results showing head flexion angle, neck flexion angle, and cervical angle of operating surgeons during different phases of lumbar fixation and fusion**

| | HFA | | NFA | | CA | | Distance | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Exposure | | | | | | | | |
| Surgeon 1 | 116.5 | 6.4334 | 55 | 4.02768 | 28.6 | 2.319 | 106.93 | 3.459 |
| Surgeon 2 | 122 | 5.9066 | 67 | 3.944 | 20.5 | 1.7795 | 138.08 | 1.5604 |
| Surgeon 3 | 130.6 | 5.4405 | 73 | 4.2018 | 17.3 | 1.6329 | 177.16 | 2.1498 |
| FIXATION | | | | | | | | |
| Surgeon 1 | 131 | 3.8005 | 60.7 | 4.5472 | 25.1 | 3.2472 | 110.22 | 2.8312 |
| Surgeon 2 | 139.8 | 2.7406 | 73.2 | 3.2591 | 19.7 | 2.3118 | 151.03 | 1.8506 |
| Surgeon 3 | 141.3 | 3.4657 | 87.6 | 3.4058 | 14.2 | 2.1421 | 179.05 | 3.2903 |
| Decompression | | | | | | | | |
| Surgeon 1 | 145 | 3.496 | 76.7 | 4.2176 | 21.2 | 2.8596 | 159.67 | 2.8627 |
| Surgeon 2 | 143.8 | 2.9363 | 80.2 | 4.1311 | 18.2 | 2.6583 | 164.17 | 3.2964 |
| Surgeon 3 | 149.7 | 4.139 | 98.7 | 4.5227 | 12.3 | 2.5841 | 190.81 | 2.56476 |
| FUSION | | | | | | | | |
| Surgeon 1 | 135.9 | 3.6651 | 68.4 | 5.3374 | 23.8 | 4.1311 | 136.53 | 2.808 |
| Surgeon 2 | 142.2 | 4.1311 | 79.7 | 3.3349 | 18 | 2.7487 | 157.91 | 2.9898 |
| Surgeon 3 | 150.8 | 4.8716 | 93.6 | 4.2216 | 12.7 | 1.7029 | 187.41 | 2.3278 |
| Closure | | | | | | | | |
| Surgeon 1 | 120.3 | 3.093 | 57.36 | 3.4719 | 28 | 2.9059 | 97.82 | 4.0746 |
| Surgeon 2 | 126.6 | 2.5033 | 67.3 | 2.6687 | 24 | 3.055 | 137.34 | 3.4296 |
| Surgeon 3 | 132.3 | 3.4657 | 77.7 | 3.4334 | 18.7 | 3.3747 | 157.56 | 3.9699 |

- HFA and NFA were significantly **higher** during decompression and fusion when compared with exposure and closure ($P < 0.05$).
- NFA seems to be abnormal in decompression and fusion. In other phases they nearly satisfy the normal distribution.

# Paper 2 Background and Method

- Purpose: survey otolaryngology residents and identify specific symptoms of early work-related musculoskeletal disorders (WMSDs)
  - Previous studies focused on practicing physicians
  - Limited information on specific symptoms experienced

- Methods:
  - Nordic Musculoskeletal Questionnaire
    - Demographic information
    - Anatomical Region and Symptom
    - Severity and Impact
    - Effect on work

# Paper 2 Result Summary

- Most common symptom sites: Neck (81%), Lower Back (55%), Shoulder (40%)
- Most common symptoms reported were neck stiffness (71.6%), neck pain (61.7%), lower back pain (48.2%)

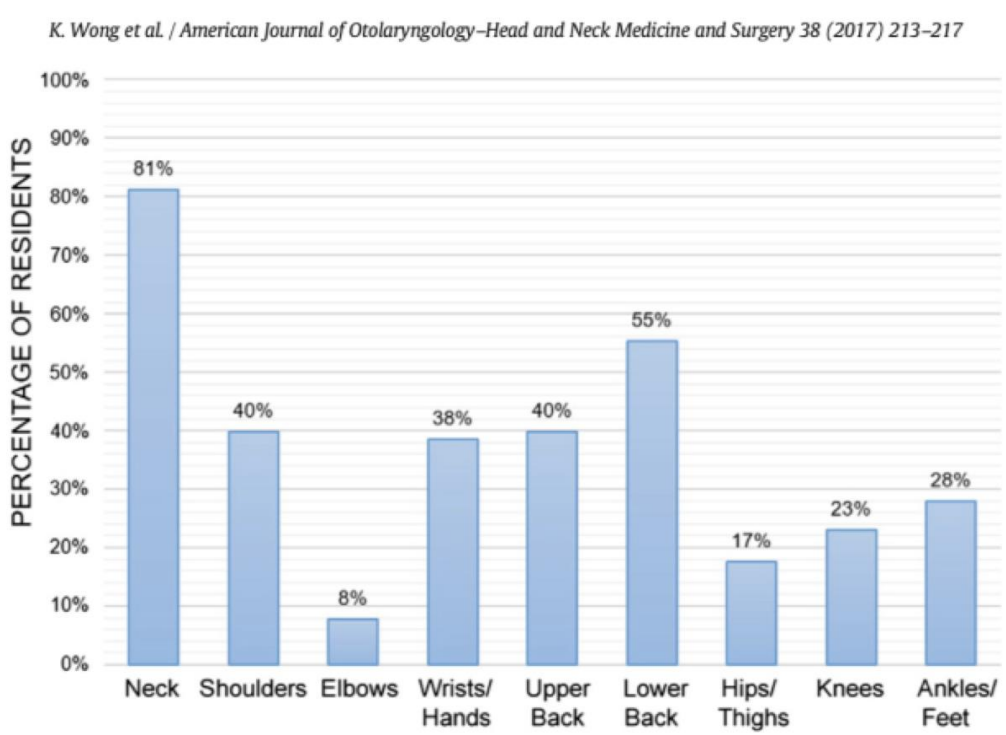



*Figure1. Musculoskeletal symptoms. Prevalence of musculoskeletal symptoms by anatomic region.*

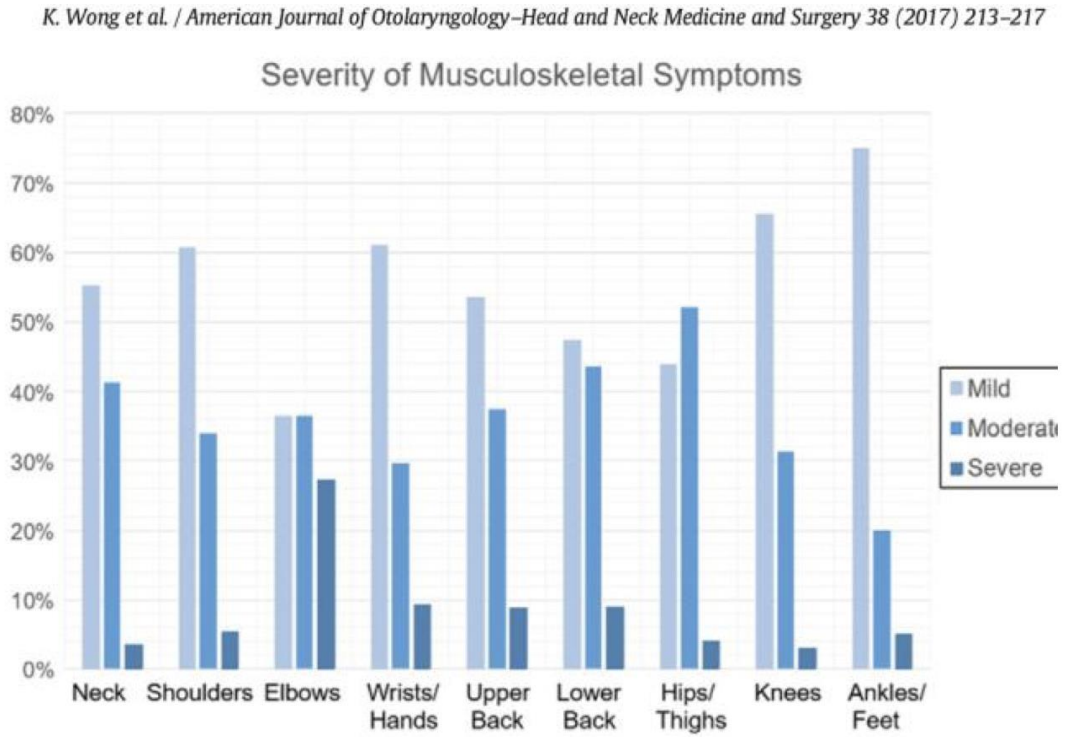



*Figure2. Symptom severity. Severity of musculoskeletal symptoms by anatomic region.*

# Paper 2 Result Summary

- 83.7% attributed their symptoms to surgical training
  - Neck WSMDs most highly attributed to training
- 76.6% experienced symptoms within the past week
- 6.4% missed work due to symptoms
- 16.3% had to stop partway through an operation due to symptoms

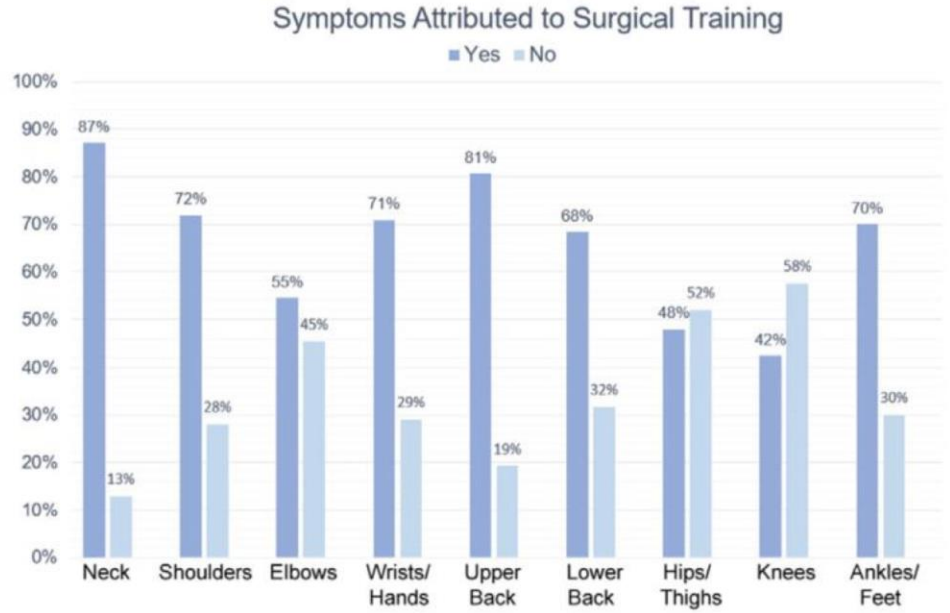



*Figure3. Surgical training as a cause for symptoms. Percentage of residents who believed their musculoskeletal symptoms were caused by their surgical training, stratified by anatomic region.*

# Paper Assessment

What we learn from two papers:

• Correct upright posture leads to less strain on the back; early intervention in surgeon's training is the best way to combat future risk and disability.
• Divide the whole surgery into different phases, calculate the mean and SD of each phase.
• Fit the curve with normal distribution for the histogram representation of the neck flexion angles.
• Besides neck flexion angle, angles in other parts of the body such as back, elbow and shoulder are also important in surgical ergonomics

# Paper Assessment

Drawbacks of two papers:

- Paper 1 didn't specify image calibration. The calibration process can influence the reliability of the data.
- The data gathered from paper 1 is not continuous. They could not collect data if the surgeon moved in the opposite direction of the camera.
- Bias is a concern in Paper 2 due to the survey design: residents who experienced musculoskeletal symptoms with stronger opinions are more likely to respond.
- Study in Paper 2 only included residents training in the United States, which limits the ability to generalize their findings to residents training in other countries.

Thank you