Critical Review

Surgeon's Neck Posture during Spine Surgeries: "The Unrecognized Potential Occupational Hazard"

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Project Overview

Our project is accurate measurement of neck flexion angles during thyroid surgery and ear surgery using two IMUs. One IMU is banded in front of surgeon's head and another one is stabilized in surgeons' back. The quaternion data from the two IMUs are used to calculate the pitch angle. After finishing the calibration and data analysis of the data from the Mock OR, we have to figure out what's the data illustrating.

Paper Selection

The paper shows a different method to get the neck flexion angle during spine surgical scenario, but it gives a great discussion and conclusion on how to analyze the data and what people can learn from those data, which can give our team some inspiration.

Paper Background

Abnormal neck posture, especially the forward head posture (FHP) were found to adversely affect the cervical spine of individual. The purpose of this study is to analyze the surgeon's neck postures while performing lumbar spinal surgeries.
Here are some terminologies we may use:

- The forward head posture (FHP)
- Head flexion angle (HFA)
- Neck flexion angle (NFA)
- Cervical angle (CA)
- Transforaminal lumbar interbody fusions (TLIFs)
- Lumbar decompression (LD)

Experiments & Methodology

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

1. Radiography: Reliable and gold standard but involves radiation hazards.
2. Three-dimensional motion analysis: Reliable but requires costly equipment.
3. Video raster stereography analysis: Reliable but did not pass validity studies.
4. Photographic posture analysis: Basic objective observational measurement method

using anatomical landmarks.

In this study, they use photographic posture analysis. An observational study of 60 videos performed by three spine surgeons (S1, S2, and S3), including 25 open transforaminal lumbar interbody fusions (TLIFs) and 35 lumbar decompression (LD) procedures ---15 with headlight and 20 with operating microscope.

Preoperatively, reflective markers were taped on the side of the surgeons shown in Figure 1, in the following surface landmarks:

1. C7 spinous process.
2. Tragus of the ear.
3. Outer canthus of the eye.

The angles evaluated in the study are described below and shown in Figure 2:

1. Head flexion angle (HFA) is the angle between a line connecting C7 to tragus of the ear and tragus to outer canthus.
2. Neck flexion angle (NFA) is defined as the angle subtended between vector pointing from C7 to tragus (which corresponds to occipital-cervical joint) and a global vertical line.
3. Cervical angle (CA) has been one of the reliable indicators to assess FHP and is defined as the angle formed at the intersection of the horizontal line through the spinous process and tragus of the ear.

Figure 1: Reflective markers taped on side of the surgeon

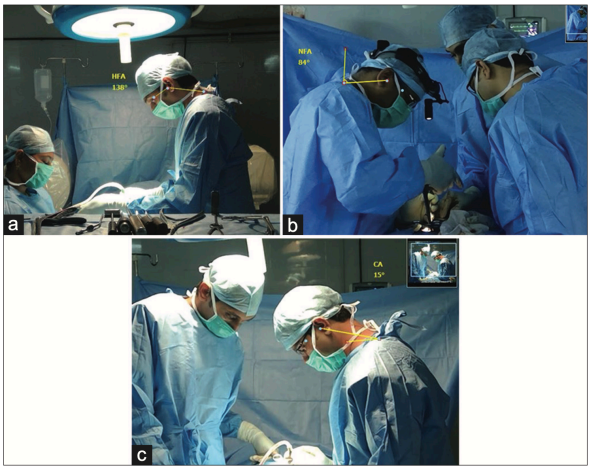

Figure 2: Snapshot pictures showing head flexion angle (a), neck flexion angle (b), and cervical angle (c) of operating surgeons

Results

Duration of the whole surgery of TLIF can be divided into different phases as exposure, fixation, decompression, fusion, and closure. Videos of LD performed were grouped into Group H – surgery performed with usage of headlight and Group M – surgery performed

under microscope. Snapshots of the video were taken whenever the surgeon changes his/her position and using Surgimap (Spine Software, version 2.2.9.9.4, New York, NY, USA), all images were calibrated.

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

Table 2: Results of lumbar discectomy performed with headlight and microscope

	HFA		NFA		CA		Distance	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Head light								
Surgeon 1	111.4	2.6331	55.5	3.3747	22	3.1269	110.96	3.3118
Surgeon 2	120.5	2.9533	58.9	4.1486	17.1	3.6651	127.1	2.9137
Surgeon 3	138	2.708	73.7	3.2676	14.4	3.2041	140.09	3.4296
Microscope								
Surgeon 1	108.5	2.9907	57.6	3.7771	38.1	3.0713	111.35	3.1502
Surgeon 2	116.1	3.5418	59.7	3.1287	36.4	3.1692	120.45	3.0297
Surgeon 3	120.9	3.9258	65.8	2.8982	31.1	2.8067	130.66	2.3527

The red bars, which indicates the neck flexion angles, are what we are interested in.

NFA of the surgeons was observed to be abnormal during decompression (S1 – 76.7 ± 4.2, S2 – 80.2 ± 4.1, and S3 – 98.7 ± 4.5) and fusion (S1 – 68.4 ± 5.3, S2 – 79.7 ± 3.3, S3 – 93.6 ± 4.2).

Decompression and fusion were observed to be the most stressful phases affecting surgeon's neck during TLIF. HFA and NFA were significantly higher during the phases of decompression and fusion when compared with exposure and closure ($P < 0.05$).

HFA and NFA did not alter much in the headlight and microscope groups, while CA showed significant difference ($P < 0.001$).

Discussion & Conclusion

Good posture is defined by the Posture Committee of the American Academy of Orthopedic Surgeons as “the state of muscular and skeletal balance which protects the supporting structures of the body against injury or progressive deformity, irrespective of the position (erect, lying, squatting, or stooping) in which these structures are working or resting”. Correct upright posture is defined as when ears are aligned with the shoulders in the same line, leading to least strain on the back when in standing position.

According to Kessel, for every inch of FHP, there is an increase in weight of head on the spine by additional 10 pounds. In the study, the average FHP of operating surgeon has been 5.3 inch which amounts to >50 pounds of head weight on the cervical spine.

Normally, the weight load of head on spine is 10–12 lbs where the neck flexion is at neutral position and center of the ear lies in the same line that of center of shoulder blades. According to Hansraj, weight load on the spine dramatically increases when there is an increase in neck flexion ranging from 10 lbs at 0° to 60 lbs at 60°. It is around 27, 40, 49, and 60 lbs at 15°, 30°, 45°, and 60°, respectively. From 60°, load could not be calculated since the modules were termed becoming unstable in higher flexion degrees. In the present study, load of head on the spine of surgeons has been consistently above 60 lbs during all the phases of surgery based on the findings of NFA.

Furthermore, the usage of microscope was found to be beneficial by avoiding the abnormal neck posture angles when compared to the usage of headlight.

Assessment

This paper is very informative on data analysis and conclusion. There are detailed explanations on how the neck flexion angle changes can lead to straight neck syndrome and how the stress and pain from the neck can be transferred to surrounding ligaments and capsules of cervical facets joint. There are several data analysis methods that our team can learn from the paper:

- We can divide the whole surgery into different phases, especially the most stressful phases and the moderate phases, calculate the mean and SD of each phase’s data.
- After we get the histogram representation of the neck flexion angles, we can try to fit the curve with normal distribution if possible.
- When do comparison between different phases or comparison between different surgical scenarios (microscope or traditional), calculate the p-value to show whether the null hypothesis is convincing or not.

About the technical approach, there are some drawbacks:

- The paper didn’t show specifically how to calibrate the images. The calibration process

can influence the reliability of the data.

- The paper didn’t show how many snapshots of the video have been taken. The condition that whenever the surgeon changes position, taking a snapshot seems a little ambiguous.
- The data gathered from this method aren’t continuous, if the surgeon move to another direction, the opposite direction of the camera, then the camera can’t gather any data.

Reference

Naresh-Babu J, Arun-Kumar V, Raju DGS. Surgeon's Neck Posture during Spine Surgeries: "The Unrecognised Potential Occupational Hazard". Indian J Orthop. 2019;53(6):758–762. doi:10.4103/ortho.IJOrtho_677_18