Copenhagen CSF Study Group

Relationship between flexion of the neck and changes in intracranial pressure

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Introduction

Intracranial pressure (ICP) is strongly influenced by posture changes

We observed that ICP decreased immediately when the neck was extended

Other investigators have shown that

- ICP can vary with neck position
- ligation of the internal jugular vein (IJV) increases CSF pressure
- ipsilateral rotation of the head reduces blood flow in IJV

Our observation led us to the hypothesis that the neck veins may be an important determinant in positional regulation of ICP

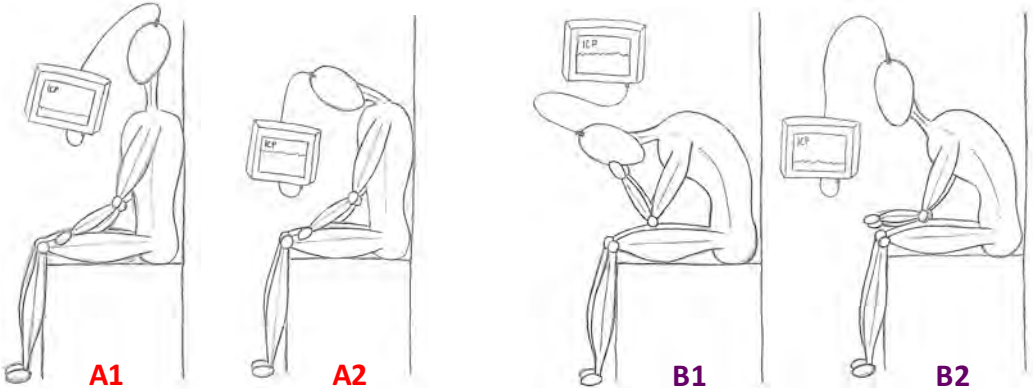
Aims;

Study I: To clarify to what extent flexion of the neck affects ICP in self-reliant patients

Study II: To visualize patency of the internal jugular vein with body and head in different positions

Methods

All patients, with a GCS score ≥ 14, undergoing postural change examination from February 2014 to March 2015 were included (n=45, 16 males, age range 10 to 81 years).



Study I:

A: the patient in **upright sitting position** with a straight back, and straight neck (**A1**) vs. maximal neck flexion (**A2**).

B: the patient in **sitting position as for a lumbar puncture** with a flexed back and maximal neck flexion (**B1**) vs. straight neck (**B2**).

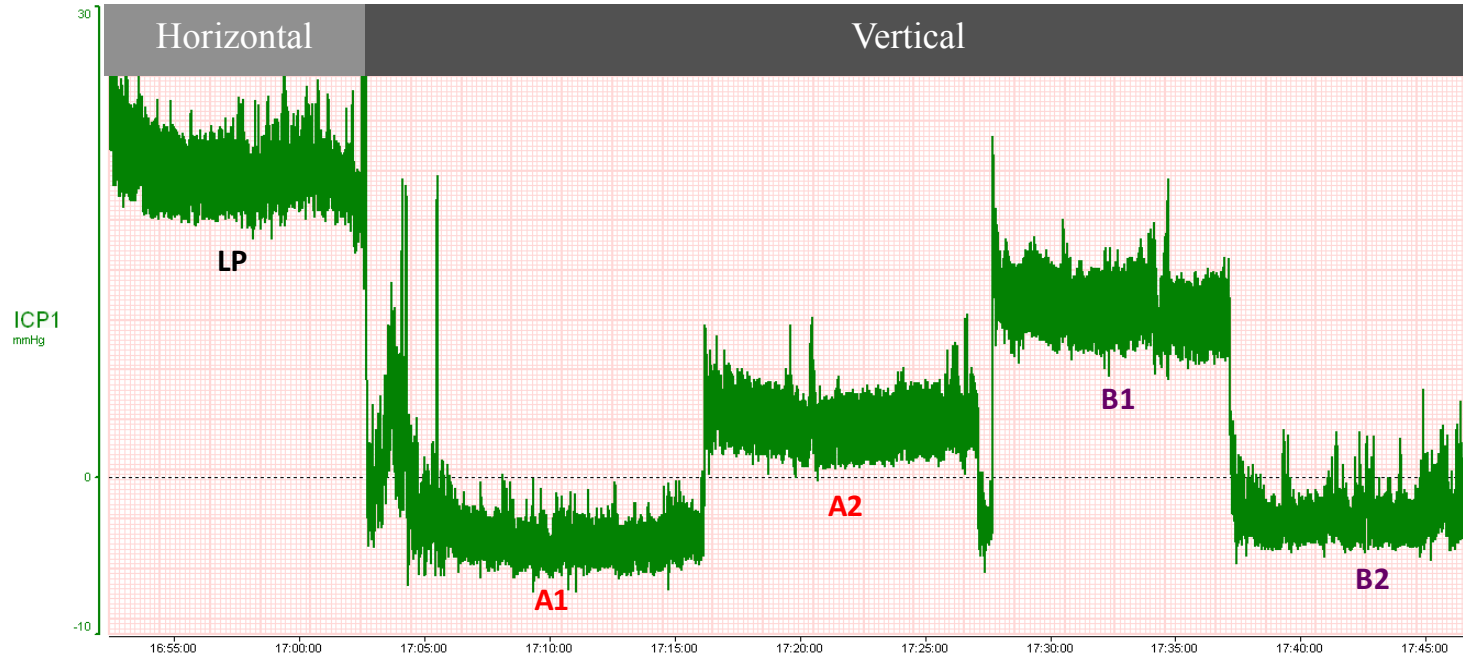
Each position was maintained for ten minutes.

Study II:

The **internal jugular vein was visualized by ultrasound** with the patient in supine position and in the four vertical positions.

For each scan the cross sectional area of the vein was measured.

Results, Study I; Correlation between neck posture and ICP



Both pressure and amplitude can be read in the curve.
The left panel shows the horizontal position, while the right panel shows the four vertical positions.

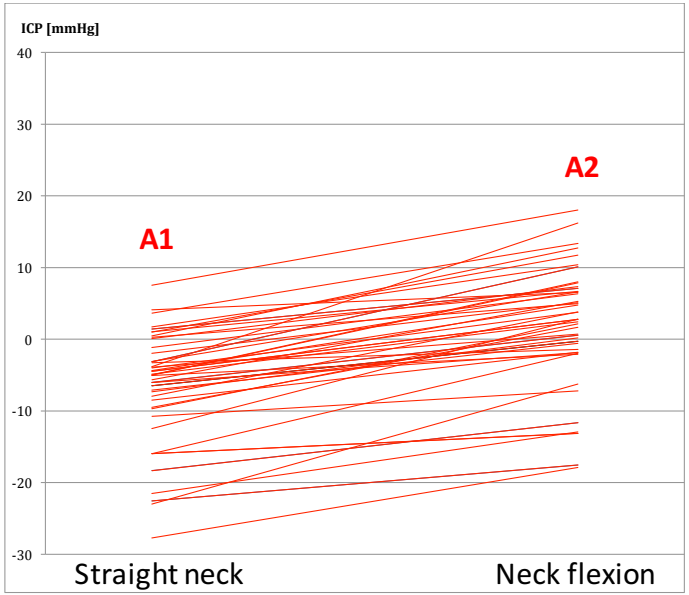
LP=lumbar puncture position

A1=**Upright sitting**, straight neck
A2=**Upright sitting**, neck flexion
B1=**Sitting LP**, neck flexion
B2=**Sitting LP**, straight neck

The figure illustrates

the typical ICP changes in different body and head postures

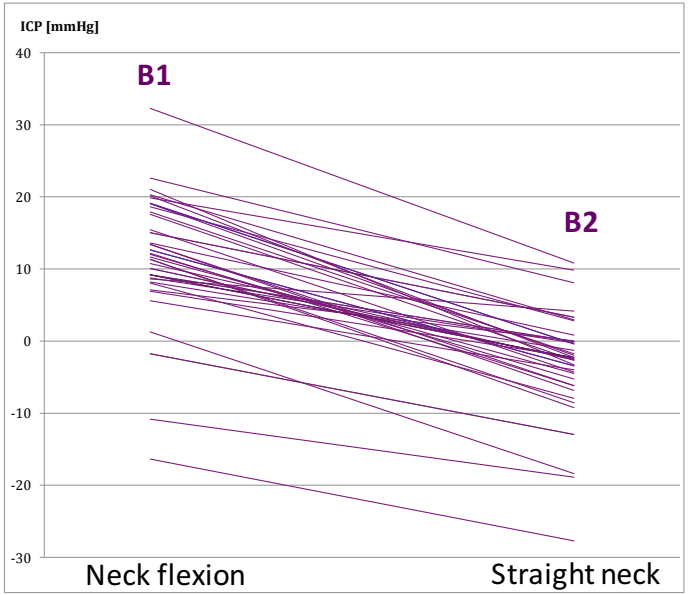
Results, Study I; Correlation between neck posture and ICP



In the upright sitting position:

All patients presented an <u>increase</u> in ICP following neck flexion

n = 42, p < 0.0001, CI95% = 7.3; 9.7



In the sitting LP position:

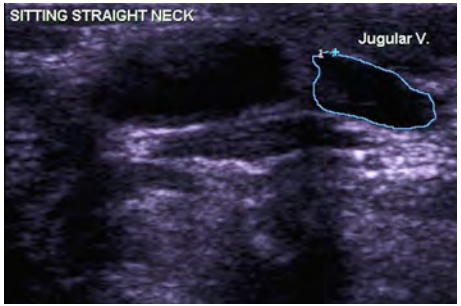
All patients presented a <u>decrease</u> in ICP following neck extension

n = 38, p < 0.0001, CI95% = -13.4; -16.6

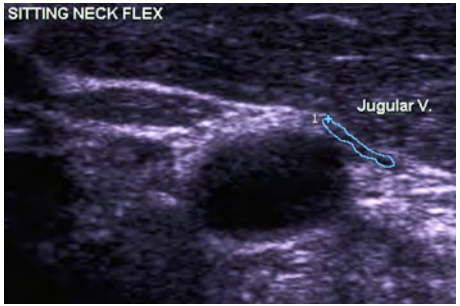
Body posture	Upright sitting		Sitting LP	
Neck posture	*Straight*	*Flexed*	*Flexed*	*Straight*
Median ICP [mmHg]	-5.0	3.3	12.0	-2.6
Median ICP change after neck flexion [mmHg]	7.5 *(range: 1.9 to 20.0)*		15.9 *(range: 4.5 to 24.3)*	

Results, Study II; Correlation between neck flexion and the IJV

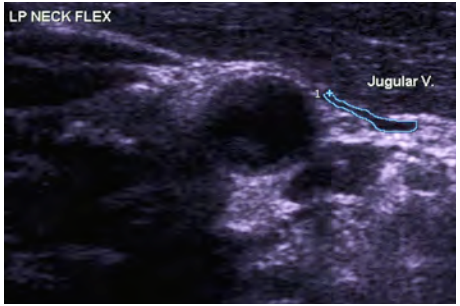
A1, Upright sitting, straight neck



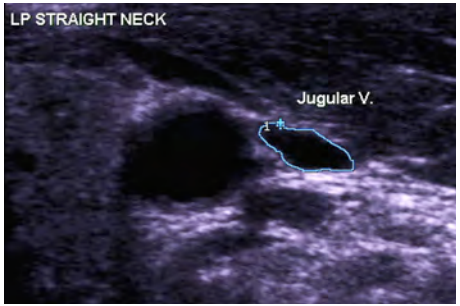
A2, Upright sitting, neck flexion



B1, Sitting LP, neck flexion



B2, Sitting LP, straight neck



The patient is a 60 year-old woman with suspected normal pressure hydrocephalus, who underwent ICP monitoring to evaluate shunt function. The circumference of IJV is marked with blue.

All patients presented a compression of the jugular vein following neck flexion

Body posture	Upright sitting		Sitting LP	
Neck posture	*Straight*	*Flexed*	*Flexed*	*Straight*
Median vein area [mm^2]	22	8	13	28
Median intraperson variation in vein area after neck flexion [mm^2]	13 *(n=9, p=0.008)*		15 *(n=9, p=0.008)*	

Conclusions

Study I: In self-reliant patients we document that

- **ICP increases in an upright sitting position with a flexed neck**
- **ICP decreases in response to neck extension in sitting lumbar puncture position**

Study II: We confirm the hypothesis that

- **the change in ICP may be caused by compression of the internal jugular vein**

The results suggest how a small intervention can have profound implications on interpretation of ICP and on clinical decisions. A neutral head position can be used as a therapeutic tool to lower ICP

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