# Predictive Model for Determining the Clivoaxial Angle Necessary in Craniocervical Fusion for the Treatment of Basilar Invagination

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## Introduction

Reduction by craniocervical fusion is a treatment option for craniovertebral instability and basilar invagination. The skull is placed into extension, anteriorly translating the odontoid, alleviating brainstem compression. Excessive extension can lead to adjacent segment pathology. Surgical planning involves measuring the clivoaxial angle (CXA) and Grabb-Oakes line (pBC2); however, it is difficult to determine the goal CXA needed to obtain desired reduction of brainstem compression (pBC2). To safely obtain optimal reduction, we propose a model to calculate preoperatively the CXA required to achieve a specific desired reduction in the pBC2.

## Methods

This is a retrospective, single institution analysis of craniocervical decompression and occiput-C2 or C3 fusions from 2012-2015. Radiographic measurements were made from pre- and postoperative MRI: CXA and pBC2. The Pearson's correlation coefficient was assessed to evaluate the correlation between the changes in CXA and pBC2. A linear regression model was developed to predict the changes in CXA needed to achieve a desired reduction of pBC2, based on patient-specific preoperative parameters.

## Results

A total of 83 patients underwent CCF. 70 met inclusion criteria for analysis. The mean preoperative CXA was significantly smaller than postoperatively (128.1±8.6 versus 146.7±9.4 degrees, p=0.0001). The preoperative pBC2 was significantly larger (9.0±1.5mm versus 6.1±1.4mm, p=0.0001). There was a strong correlation between the changes in CXA and pBC2 postoperatively (R=-0.778, p<0.00001). The linear regression model to predict the postoperative CXA needed based on preoperative CXA and pBC2 to obtain a desired postoperative pBC2 had a strong fit (R2=0.6045) – Figs:1,2.

## Conclusions

There is a strong correlation between the change in CXA and pBC2. A model that utilizes individual preoperative CXA and pBC2 measurements to predict postoperative changes is feasible. This assists with optimizing presurgical planning, reducing intraoperative guesswork in obtaining an optimal balance between ventral brainstem decompression and stability for patients with basilar invagination due to craniocervical instability.

## Learning Objectives

1) Understand the relationship between the clivoaxial angle (CXA) and Grabb-Oakes Line (pBC2) during craniocervical fusion

2) Understand the effect of extension on increasing the risk of adjacent segment pathology

3) Be able to predict the CXA required to obtain the desired amount of ventral brainstem decompression (reduction of pBC2) based on preoperative patient specific parameters

4) Appreciate the need for balance between reduction of ventral basilar invagination and craniocervical instability.

## References

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## Predictive Model to Determine CXA and pBC2

Figure 1:

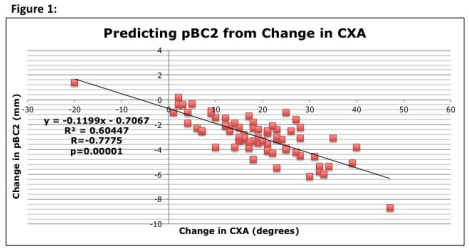


Figure 2:

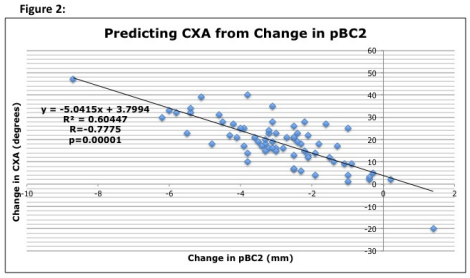


Figure 3: