



## Letter to the Editor

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# Reply to Commentary on “A Universal Craniometric Index for Establishing the Diagnosis of Basilar Invagination”

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To the editor,

We read with great interest the commentary on “A Universal Craniometric Index for Establishing the Diagnosis of Basilar invagination”.<sup>1</sup> The critical appraisal given by author is commendable.

Craniovertebral anomalies are more frequently found in the Indian subcontinent (Uttar Pradesh, Bihar, Rajasthan, and parts of Gujarat states) than anywhere else in the world. Due to unknown geographical factor, at our institute (SGPGIMS, Uttar Pradesh, India) it is one the most common spine anomalies we frequently encountered in our day-to-day routine practice. In our previous extensive research work on craniovertebral junction (CVJ) anomalies, we found that type A basilar invagination (BI), is usually coexisted with atlantoaxial dislocation, rotational dislocation, and coronal tilt due to underlying anomalous facet joints.<sup>2</sup> Multiple CVJ congenital anomalies simultaneously coexist usually. Goel classification of basilar invagination (type A and B) is not based on etiological factors but rather purely is on radiological and clinical basis depend upon presence or absence of atlantoaxial dislocation and/or Chiari malformation.<sup>3</sup> Basilar invagination is congenital or acquired is still debatable and hence not yet proven. Pang and Thompson<sup>4</sup> suggested that the common embryological basis for the association of congenital atlantoaxial dislocation (AAD), BI, platybasia, Arnold-Chiari malformation type I, and rotational deformity is the presence of congenital occipital dysplasia. Therefore, all the subsequent events of facet joint dislocation are probably mechanical events influenced by congenital etiological factors.

In the study of 154 patients of congenital CVJ anomalies, more than 70% patient of BI (both the type A and B) were associated with occipitalised atlas.<sup>2</sup> Similar result has found in our own different studies.<sup>1,2,5-10</sup> In our study, out of 268 patients, 89 cases were irreducible AAD with BI (all the reducible BI cases excluded), means the relationship of proposed landmarks (tip of the hard palate and inion) and odontoid tip has not changed with flexion and extension (as BI does not reduce on dynamic study). The fact is confirmed that, the minimum perpendicular distance from odontoid tip to palate-internal occipital protuberance (P-IOP) line remain same in all the dynamic state of the neck. The P-IOP line does not affect by head position in the diagnosis of BI.

Study is written under highly standard STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines. Moreover, we have also fulfilled the majority criteria of STARD (Standards for Reporting of Diagnostic Accuracy) statement in the study



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to propose newer diagnostic index (sensitivity, specificity, area under the curve [AUC], receiver operating characteristic analysis, cutoff value of our newer diagnostic study, rationale of the diagnostic method over alternative method to diagnose the BI, eligibility of the patients for study, flow of participants using flow diagram and diagnostic accuracy and precision).

We appreciated the critical observation and admit that the reproducibility which we have found in our 2 different groups observations during BI measurement by P-IOP line should have been mentioned in details in the method and result section. Further study on reproducibility is desired, and we are being currently focusing on it with the planning to published in the literature as a upcoming separate study.

The Boogard's angle is highly reliable index for type B BI, however, on comparison, the measurement of BI by P-IOP line can provide added advantage of diagnosing both the types of BI (A and B) by single universal index with comparable accuracy with 0.853 AUC value for 8.99 mm with 76.2% sensitivity and 79.3% specificity. The degree of severity of myelopathy is directly depend upon the effective canal diameter at CVJ. High basilar invagination would produce further severe compression of cervical medullary junction due to compromised effective canal diameter by odontoid tip.<sup>9,10</sup> More the compression by odontoid tip more the severity of compressive symptoms and myelopathy.<sup>2,9-11</sup> If tip of odontoid is crossed the P-IOP line we referred it high BI in our article, off course it helps in decision making during planning of surgical decompression compare to normal basilar invagination.

A comparison of the distance of odontoid tip to the P-IOP line and the Chamberlain line for establishing the diagnosis BI is already mentioned in the discussion part (using Spearman rho correlation test) revealed a significant negative correlation (correlation coefficient = -0.39, p = 0.002) in these patients.

Comment on figures is genuine, as Fig. 3 graphics could have been better than represented in the article, but the precise idea is to measure the minimum perpendicular distance from P-IOP line to tip of odontoid process could be appreciable. Fig. 1A and B is the representative images of BI with occipitalised atlas where basion and opisthion could not appreciated separately but anomalously attached with clivus and occiput respectively. That is actually the rationale behind the criticism of this two-landmark utilization for diagnosis of BI. In Fig. 1C, opisthion could not find separately that could appear as a false reading during BI measurement. Finally, we would like to congratulate the author for nice commentary and review of our article, we are grateful for the same.

## CONFLICT OF INTEREST

The authors have nothing to disclose.

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