



**IMPROVEMENT OF DIAGNOSTIC METHODS FOR CROSSBITE IN  
CHILDREN DURING MIXED DENTITION**

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**Introduction**

Crossbite is a transverse occlusal abnormality characterized by an abnormal buccolingual relationship between the maxillary and mandibular teeth. It may occur as a result of abnormal tooth position, transverse deficiency of the maxillary dental arch, asymmetrical development of the dental arches, or functional mandibular displacement. In children during mixed dentition, timely diagnosis of crossbite is particularly important because persistent functional displacement may influence the development of the dentofacial complex and contribute to facial asymmetry and abnormal occlusal relationships.

The diagnosis of crossbite should not be limited to the assessment of occlusal contacts. A comprehensive diagnostic approach should include clinical examination, evaluation of facial symmetry, assessment of dental arch dimensions, analysis of mandibular displacement, and determination of tooth-size relationships.

Diagnostic casts remain an important source of information in orthodontic diagnosis. Biometric measurements of dental arches allow the orthodontist to determine transverse discrepancies, asymmetry, dental arch length and width, and the relationship between individual tooth dimensions and arch parameters.

The Bolton analysis is one of the established methods for evaluating tooth-size discrepancy between the maxillary and mandibular dentitions.



Bolton demonstrated that the mesiodistal dimensions of mandibular teeth have a relatively constant proportional relationship with the corresponding dimensions of the maxillary teeth. The anterior ratio is approximately 77.2%, while the overall ratio for 12 teeth is approximately 91.3%. Deviations from these values may indicate tooth-size discrepancies that should be considered during orthodontic treatment planning.

Recent international literature also emphasizes the importance of early diagnosis and treatment of crossbite during the mixed dentition period. Systematic reviews have demonstrated that different expansion and interceptive orthodontic approaches can modify maxillary transverse dimensions and correct functional mandibular displacement, although the strength of evidence varies depending on the treatment modality and study design.

Therefore, the development of rapid and objective diagnostic methods that combine conventional biometric assessment with computer-assisted analysis is of practical importance.

## **Aim**

To improve the diagnosis of crossbite in children during mixed dentition by combining conventional clinical and biometric examination methods with computer-assisted Bolton analysis of dental casts.

## **Materials and Methods**

The study included **114 children aged 6–14 years** who were examined during the mixed dentition period.

The main group consisted of **76 children with crossbite**, while **38 children with physiological occlusion and without clinically significant dentoalveolar anomalies** constituted the control group.

According to the stage of mixed dentition, the children were divided into two age groups:

- early mixed dentition — 6–9 years;





- late mixed dentition — 10–14 years.

Among the children with crossbite, 43 patients demonstrated transverse dentoalveolar abnormalities predominantly associated with abnormal positioning of the maxillary teeth, while 33 patients demonstrated abnormalities associated predominantly with abnormal positioning of the mandibular teeth.

The diagnostic protocol included clinical examination, anamnesis, facial anthropometry, photometric assessment, examination of diagnostic dental casts, and functional evaluation.

The following biometric methods were used:

1. **Pont's method** — assessment of transverse dental arch width in the premolar and molar regions.
2. **Korkhaus method** — assessment of the anterior segment length of the dental arch.
3. **Howes–Snagina method** — assessment of apical base dimensions.
4. **Fuss method** — evaluation of dental arch symmetry using diagnostic triangles.
5. **Symmetroscopy** — quantitative assessment of transverse and sagittal asymmetry of the dental arches.
6. **Bolton analysis** — assessment of the proportional relationship between mesiodistal tooth dimensions of the maxillary and mandibular dentitions.

Diagnostic casts were prepared from dental impressions and used for biometric measurements. The mesiodistal dimensions of permanent teeth were measured and entered into a computer-assisted calculation system.

A specialized computer program, **ABolton.exe**, was developed for rapid Bolton analysis. The program was registered in the State Register of Computer



Programs of the Republic of Uzbekistan under **Certificate No. DGU 21543**  
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The anterior Bolton ratio was calculated as:

**Anterior ratio = mandibular 6 anterior teeth / maxillary 6 anterior  
teeth × 100**

with a reference value of approximately **77.2%**.

The overall Bolton ratio was calculated using the mesiodistal dimensions  
of 12 mandibular and 12 maxillary teeth, with a reference value of  
approximately **91.3%**.

Statistical processing was performed using Microsoft Excel. Differences  
between groups were evaluated using Student's t-test.

### **Results**

Clinical examination demonstrated different forms of crossbite,  
including unilateral and bilateral variants, with and without mandibular  
displacement.

Among children with mandibular displacement, unilateral palatal  
occlusion was the most frequently observed form. Bilateral palatal occlusion  
and unilateral vestibular or lingual occlusal relationships were also identified.

Functional and esthetic complaints were common. All children with  
crossbite demonstrated abnormal tooth positioning. In addition, **85.52%** of  
patients reported impaired chewing function, **30.26%** demonstrated trauma or  
contact of teeth with the buccal mucosa, and **39.47%** had clinically detectable  
facial asymmetry.

The analysis of etiological factors demonstrated that crossbite was  
associated with several local and functional factors, including impaired nasal  
breathing, premature loss of deciduous molars, abnormalities of deciduous  
molars, agenesis of permanent teeth, supernumerary teeth, and abnormal  
eruption or positioning of permanent teeth.



Facial anthropometric examination demonstrated that the majority of children retained generally harmonious facial proportions; however, specific indices revealed asymmetry in the lower facial region and mandibular soft-tissue profile in a proportion of patients.

Biometric analysis of diagnostic casts demonstrated significant transverse abnormalities of the dental arches.

In children with crossbite associated predominantly with maxillary dental displacement, narrowing of the maxillary dental arch was especially pronounced in the premolar and molar regions. Premolar narrowing of different severity was observed, with more pronounced transverse deficiency frequently occurring in the molar region.

Korkhaus analysis demonstrated shortening of the anterior dental arch segment in a proportion of patients, indicating that crossbite may be accompanied not only by transverse but also by sagittal changes in dental arch morphology.

The Howes–Snagina analysis demonstrated changes in the dimensions of the apical base. In the first group, reduction in apical base length was identified in approximately 75% of cases, while narrowing of the apical base was observed in approximately 78.6% of patients.

Fuss analysis and symmetroscopy demonstrated asymmetry of the upper and lower dental arches. In patients with predominantly maxillary involvement, the greatest transverse discrepancy was observed in the premolar region.

The absolute difference between corresponding perpendicular measurements in the maxillary arch reached approximately  $3.2 \pm 0.9$  mm in the second premolar region. In the mandibular arch, the corresponding discrepancy was smaller but remained clinically detectable.

In patients with predominantly mandibular dental involvement, asymmetry was particularly pronounced in the second premolar and first molar





regions. The absolute differences between corresponding measurements reached approximately  $3.0 \pm 0.8 \text{ mm}$  and  $2.6 \pm 0.05 \text{ mm}$ , respectively.

These findings indicate that crossbite in mixed dentition may represent a complex dentoalveolar disorder involving asymmetrical tooth positioning rather than an isolated transverse occlusal contact.

## **Bolton Analysis and Computer-Assisted Diagnosis**

The Bolton analysis provided additional information regarding the relationship between the mesiodistal dimensions of the maxillary and mandibular teeth.

The anterior ratio was used to identify discrepancies involving the six anterior teeth. A ratio above the reference value may indicate relatively larger mandibular anterior teeth or relatively smaller maxillary anterior teeth, whereas a lower ratio may indicate the opposite relationship.

The overall ratio was used to assess the relationship between the mesiodistal dimensions of 12 maxillary and mandibular teeth. If the anterior ratio was within the expected range but the overall ratio demonstrated a discrepancy, the difference could be associated predominantly with the premolars and first molars.

The developed **ABolton.exe** program automated these calculations and provided rapid assessment of the tooth-size relationship.

The main practical advantage of the computer-assisted method was the reduction of manual calculations and the possibility of obtaining the Bolton ratio directly after entering the mesiodistal dimensions of the teeth.

The program also allowed the obtained measurements to be archived and subsequently used for comparative analysis.

## **Discussion**

The findings demonstrate that diagnosis of crossbite during mixed dentition requires a multidimensional approach. Evaluation of occlusal contacts





alone may not adequately identify the underlying dental arch asymmetry or tooth-size discrepancy.

This is particularly important in unilateral crossbite associated with functional mandibular displacement. International systematic reviews have shown that early treatment of functional unilateral posterior crossbite can modify maxillary transverse dimensions and may improve occlusal relationships. However, the available evidence varies in quality, and differences exist between appliance types and treatment protocols.

A 2022 systematic review and meta-analysis of early treatment in children aged approximately 6–12 years reported that quad-helix treatment produced greater intermolar expansion and shorter treatment duration than expansion plates in the analyzed studies, although the certainty of evidence ranged from very low to moderate.

Therefore, accurate assessment of the transverse component of the anomaly before treatment remains essential.

The present approach combines established biometric methods with computer-assisted Bolton analysis. This makes it possible to assess not only the transverse dimensions of the dental arches but also the proportional relationship between individual tooth sizes.

The relevance of Bolton analysis in children with dentoalveolar anomalies is also supported by local research. Akbarov et al. reported the use of Bolton biometric analysis of plaster models in children with dentoalveolar anomalies and emphasized the potential of computer technologies for predicting discrepancies between maxillary and mandibular dental arch dimensions.

Thus, computer-assisted analysis can be considered an additional diagnostic component rather than a replacement for clinical examination, radiographic assessment, or cephalometric analysis when these methods are clinically indicated.





### Conclusion

1. Crossbite during mixed dentition is a multifactorial dentoalveolar abnormality that may be associated with transverse dental arch narrowing, asymmetry, abnormal tooth positioning, and functional mandibular displacement.
2. Comprehensive diagnosis should include clinical examination, facial anthropometry, photometry, analysis of diagnostic casts, and biometric assessment of the dental arches.
3. Pont, Korkhaus, Howes–Snagina, Fuss, and symmetroscopy methods provide complementary information regarding transverse and sagittal dental arch dimensions and asymmetry.
4. Bolton analysis provides additional information about discrepancies in mesiodistal tooth dimensions between the maxillary and mandibular dentitions.
5. The **ABolton.exe** computer program facilitates rapid calculation of anterior and overall Bolton ratios and can simplify the interpretation of tooth-size discrepancies.
6. Computer-assisted Bolton analysis may be used as an additional diagnostic tool in orthodontic treatment planning for children with crossbite during mixed dentition.
7. Further clinical studies with larger samples and standardized diagnostic and treatment protocols are required to determine the diagnostic and prognostic value of computer-assisted biometric analysis.

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