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# COMPARATIVE STUDY OF THE CROSS-SECTIONAL DISCREPANCY OF THE JAWS WITH THE UPENN AND YONSEI METHODS, EVALUATED IN CONE BEAM COMPUTED TOMOGRAPHY, LIMA 2023.

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**Abstract**
**Objective**: The objective of this research was to determine the sensitivity, specificity and diagnostic accuracy of the UPenn and Yonsei methods, evaluated in Cone Beam computed tomography, Lima 2023.
**Materials and methods**: 95 tomography scans were used, which were standardized to perform the respective measurements of both jaws: upper and lower. The discrepancy of these was then determined by performing the tomographic analyses of UPenn and Yonsei.
**Results**: Sensitivity shows the proportion of patients with cross-sectional discrepancy who were correctly detected by the Yonsei method, in the present study it was 59.46%, while specificity evidenced the proportion of patients without discrepancy, which were detected by the Yonsei method, constituting 66.67% of the sample. Finally, Yonsei's method presented a diagnostic accuracy of 61.05%.
**Conclusions**: The UPenn method has greater diagnostic sensitivity, while the Yonsei method has more diagnostic specificity in the evaluation of cross-sectional discrepancies.

**Keywords:** Cross-sectional analysis[(1),] Cross-sectional discrepancy[(2),] specificity[(3),] sensitivity and diagnostic accuracy [(4).]

## Resumen
**Objetivo**: El objetivo de la presente investigación fue determinar la sensibilidad, especificidad y exactitud diagnóstica de los métodos UPenn y Yonsei, evaluados en tomografías computarizadas Cone Beam, Lima 2023. **Materiales y métodos**: Se emplearon 95 tomografías, las cuales fueron estandarizadas para realizar las respectivas mediciones de ambos maxilares: superior e inferior. Luego se determinó la discrepancia de éstas realizándose los análisis tomográficos de UPenn y de Yonsei. **Resultados**: La sensibilidad muestra la proporción de pacientes con discrepancia transversal que fueron detectados correctamente por el método de Yonsei, en el presente estudio fue del 59,46%,mientras que la especificidad evidenció la proporción de pacientes sin discrepancia, los cuales fueron detectados por el método de Yonsei constituyendo el 66,67% de la muestra. Finalmente,el método de Yonsei presentó una exactitud diagnóstica de 61.05%.
**Conclusiones**: El método de UPenn tiene mayor sensibilidad diagnóstica; mientras que, el método de Yonseitiene más especificidad diagnóstica en la evaluación de las discrepancias transversales.
**Palabrasclave:** Análisis transversal[(1)], Discrepancia transversal[(2)], especificidad[(3)], sensibilidad y exactitud diagnóstica [(4).]

## Introduction
Transverse discrepancy of the jaws is a prevalent skeletal problem in the field of orthodontics and the craniofacial region, with significant clinical implications that extend beyond dental occlusion. This condition has been primarily linked to posterior crossbite, tooth crowding, and the presence of "negative spaces" within the oral cavity during smiling. However, this discrepancy can often go unnoticed due to the compensatory tilt of the back teeth, which can result in inaccurate diagnoses. The consequences of failing to adequately identify or treat this discrepancy can include an accentuated Wilson curve, premature contacts, occlusal interferences, periodontal complications, increased masticatory muscle activity, an elevated risk of temporomandibular dysfunction, and alterations in masticatory function. The condition has been associated with a variety of physiological manifestations, including but not limited to muscle dysfunction, facial asymmetry, and a reduction in the volume of the upper airway. These alterations have been shown to favor mouth breathing and to increase the risk of sleep apnea. [1] [2–5] [6,7] [1,4]

Orthodontists seek to address malocclusions by leveraging the unique information provided by each of the three planes of space, as they are essential for determining the direction of growth. Therefore, an accurate evaluation of the maxillomandibular transverse dimensions is imperative for the identification of potential asymmetries and crossbite issues. Such an evaluation is also essential for the effective planning of orthodontic and orthosurgical treatment. [5,6,8–21]
A plethora of methodologies have been advanced to facilitate the diagnosis of skeletal transverse alterations. However, the majority of these models were designed for dental models or for the analysis of traditional two-dimensional posteroanterior cephalograms (PA), which present significant limitations in terms of reliability and validity (9, 13, 22). Conversely, Cone Beam Computed Tomography (CBCT) has ushered in a paradigm shift in the evaluation of craniofacial dimensions. This technological advancement

provides high-resolution three-dimensional images devoid of distortions or anatomical overlaps, thereby facilitating personalized diagnoses through the utilization of three-dimensional prints derived from these images. [5,13,21,23–25]
Among the most recognized tomographic methods for measuring maxillomandibular transverse discrepancy are the UPenn analysis and the Yonsei analysis. The UPenn analysis widely referenced and studied in recent years and in different researches; [5,7,8,13,22,26] focuses on measuring the maxillary width, taking as a reference the bilateral maxillary points (Mx-Mx) and for the mandible width the WALA Ridge line, a stable bone structure located near the cortex of the bone at the level of the bifurcations of the first molars [3,5,7,13] . Because the mandibular width is not modified by the treatment, the WALA line is a stable basis for this analysis and a reference point for the lateral edges of the maxilla [7,11] . On the other hand, the Yonsei analysis is the measurement of the maxillary and mandibular width in the strength centers (CR) of the first permanent molars, that remain stable in the face of dental tilt. [27] Both are easy to reproduce and widely used in clinical practice and research.
These methods facilitate the accurate measurement of bone structures with high precision and low radiation, allowing differences in maxillary and mandibular widths to be determined to diagnose transverse deficiencies reliably.
Given that numerous orthodontic complications stem from a paucity of cross-sectional diagnosis and inadequate instrumentation, it is imperative to select the most reliable method for their evaluation. The objective of this study is to ascertain the sensitivity, specificity, and diagnostic accuracy of the UPenn and Yonsei methods when evaluated in a sample of CBCT tomography. This investigation is conducted with the aim of optimizing the diagnosis and treatment of maxillomandibular transverse discrepancies.

## Material and Methods

### Design and study area

The present study used an observational, analytical, retrospective and cross-sectional design.

### Population and sample

The study sample consisted of 95 Cone Beam Computed Tomography (CBCT) scans obtained from a private radiological center. These scans met the following parameters: The patient should be positioned with an open mouth, without a chin guard, at maximum intercuspation, and in the natural position of the head.
The following criteria were included in the selection process: patients over 12 years of age, of both sexes, with first permanent molars present, completely erupted, and premolars with any kind of malocclusion, without previous orthodontic treatment, without anomalies in dental morphology, without caries, without fracture, without restorations, and without periodontal disease.

### Sample size:

The sample size was calculated using a finite sample formula. A confidence level of 95% and absolute accuracy of 5% was established. As a result, a sample size of 95 CT scans was determined**.**

**Sampling Type:**
The SPSS epidemiological package version 29 was used to perform a simple random probabilistic sampling, to select 95 tomographies.

**Variables and instruments:**
Each CT scan was evaluated by a trained investigator and calibrated in cross-sectional width measurements for both the UPenn and Yonsei methods. The measurements were carried out using a millimeter ruler from the same software as the CT scans.

Prior to performing the measurements of the cross-sectional widths in both methods, the tomographies were standardized as follows:
1. Enlarge coronal view, taking the bipupillary line as a reference (Figure 1).
2. Maximize axial view to obtain the same size of both eyeballs (Figure 2).

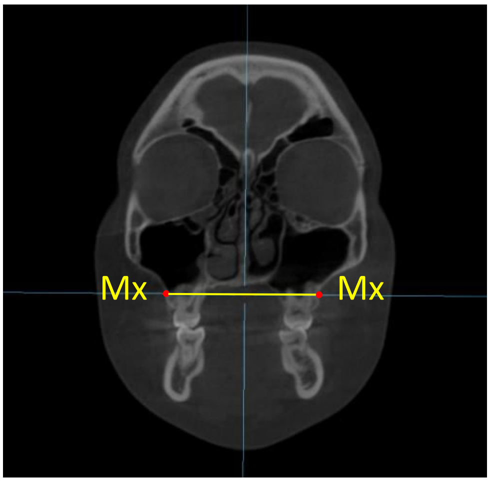



*Figure 1: Coronal View: Bipupillary Line*

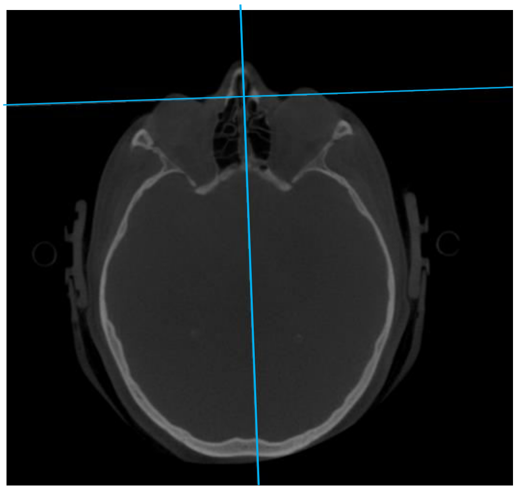


*Figure 2: Axial View: Eyeballs*

Source: Own image

**For the UPenn method:**
1. For the upper jaw, a coronal view was used, taking the Maxillary point (Mx) as an anatomical reference, both right and left [18,19] (Figure 3).
2. The measurement was performed in an axial view in the same anatomical references mentioned (Figures 4 and 5).
3. For the mandible, the coronal cut was worked on and the WALA Ridge was located; the reference line in the projection of the bifurcation of the root of the first permanent molar at the basal level (Figure 6).
4. The measurement was made in an axial view, from a more external point of the cortical from the right side to the left side (Figures 7 and 8).
5. Finally, the difference in the transverse widthsbetween the two arches is established, with the average value being 5mm; that is, the maxilla is 5mm larger than the mandible [18,19] (Figure 9).

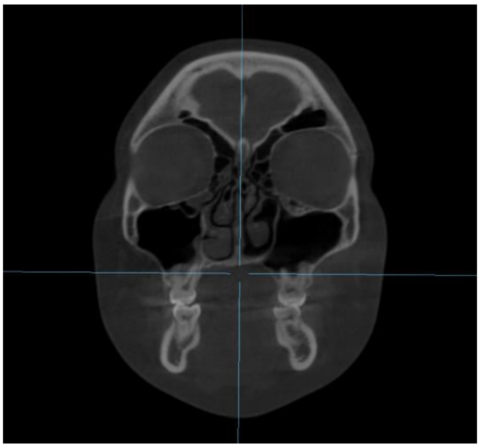


***Figure 3****: Coronal View: Maxilla (Mx-Mx)* *(Mx-Mx)*

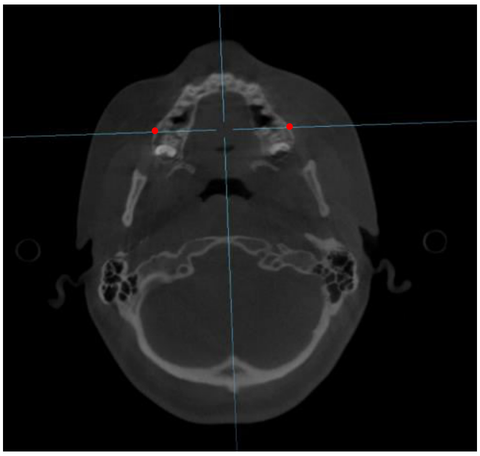


***Figure 4****: Axial View: Maxilla*

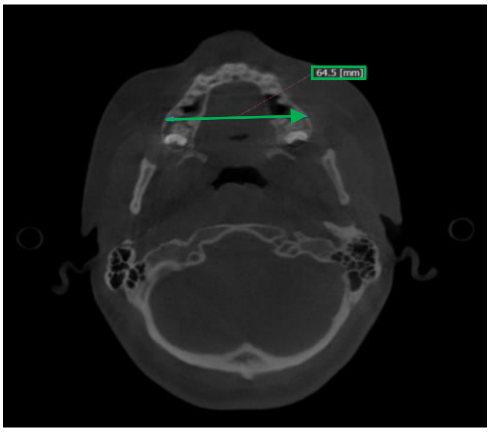



***Figure 5****: Measurement of maxillary width in the Axial sight (64.5mm)*

Source: Own image

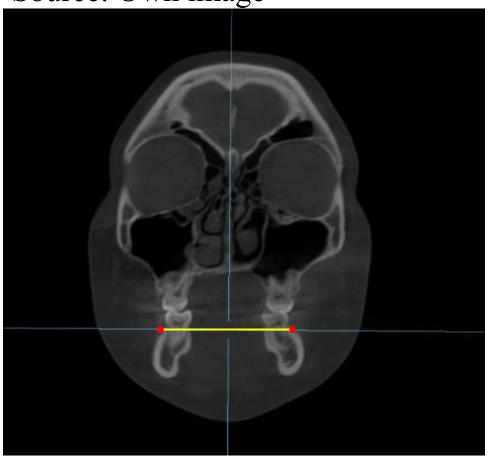


***Figure 6****: Coronal view: Mandible (Root bifurcation projection of the 1st molar at basal level)*

Source: Own image.

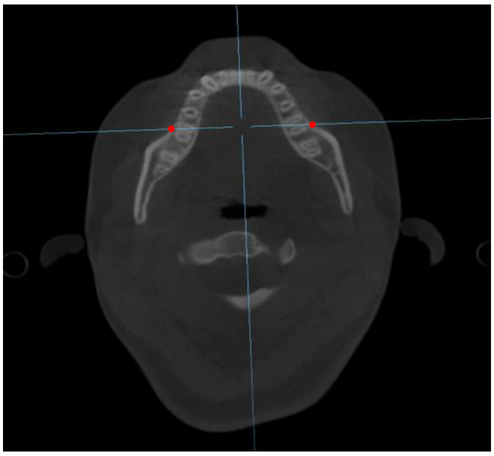


***Figura 7****: Vista axial: Mandíbula (Proyección de la bifurcación de la raíz de la 1era molar a nivel basal)*

Source: Own image

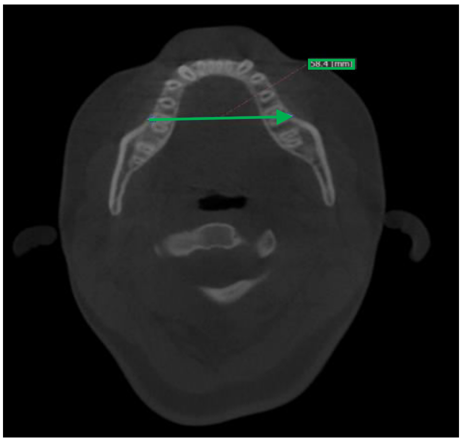
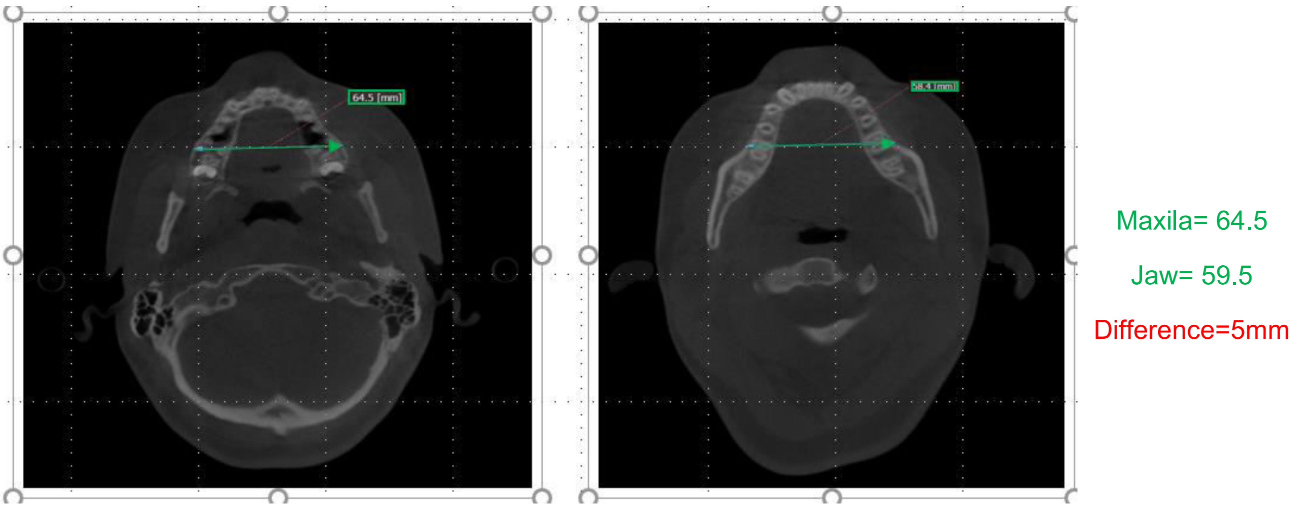



***Figure 8****: Jaw width measurement in axial view (58.4mm)*

Source: Own image

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**For the Yonsei method:**

1. For both the upper jaw and the mandible, work was done on the coronal view, taking as references the resistance centers (CR-CR) of the upper and lower first molars, which are located at the level of the root bifurcations.
2. The measurement was carried out in a linear manner, taking as a reference these anatomical points on the right and left side.
3. Finally, the difference between the two arcades is established from a transversal point of view. The average difference in intermaxillary widths in the centers of resistance in normocclusion is -0.39 mm ± 1.87 mm [2,3,20,21] (Figure 10).

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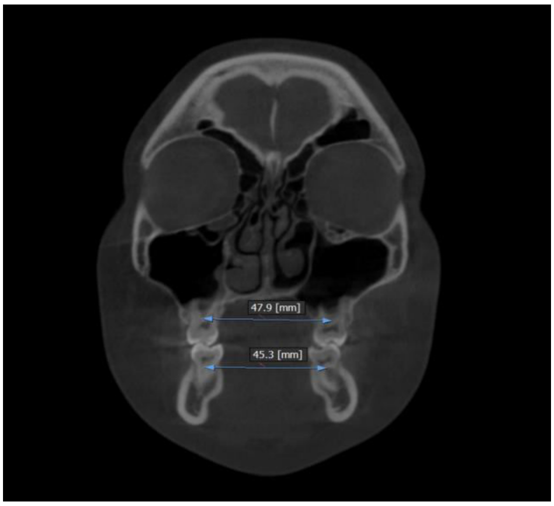


***Figure 10**: Difference in the transverse widthsbetween both arches in Coronal view taking as reference the CR of the upper and lower 1st molars.*
Source: Own image

**Covariates:**
Sociodemographic variables included age, sex, and dentition type

**Statistical analysis:**
With the information obtained, a database was created in a spreadsheet of the Excel Office 2024 program, then exported to SPSS version 29, to calculate the sensitivity, specificity, diagnostic accuracy, positive predictive value (PPV) and negative predictive value (NPV) of the UPenn and Yonsei methods.
Subsequently, cross-tables of the diagnostic tests were developed with the Yonsei method in reference to the UPenn method.

**Ethical aspects**
For the execution of this research project, the Exemption from review of the Institutional Research Ethics Committee of the Norbert Wiener Private University was obtained. As it is a retrospective study based on tomographic images. Patient information is kept anonymous

**Results**
In this study, a total of 95 CT scans were analyzed, of which 60 corresponded to female patients and 35 to male patients; The mean was 22.5 years, with ages ranging from 12 to 42 years (42 adolescents, 32 young adults, and 21 adults). It was observed that adolescent patients (42%) had a higher percentage compared to adult patients (22.1%), which coincides with the stage of greatest demand for orthodontic treatments, a period in which alterations in the growth and development of the jaws are detected and corrected.
Regarding the type of dentition, it was observed that most of the CT scans were indicated in patients with established dentition (76.8%), possibly to plan more complex orthodontic treatments.
Table 1 describes the sociodemographic, epidemiological, and clinical characteristics of the patients who made up the sample studied.

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**Table 1**

| **Sociodemography** | | Frequency | % valid | Cumulative % |
|---|---|---|---|---|
| Sex | Man | 35 | 36,8 | 36,8 |
| | Woman | 60 | 63,2 | 100,0 |
| Age | Adolescent | 42 | 44,2 | 44,2 |
| | Young Adult | 32 | 33,7 | 77,9 |
| | Adult | 21 | 22,1 | 100,00 |
| Dentition | Young Permanent | 22 | 23,2 | 23,2 |
| | Permanent | 73 | 76,8 | 100,00 |

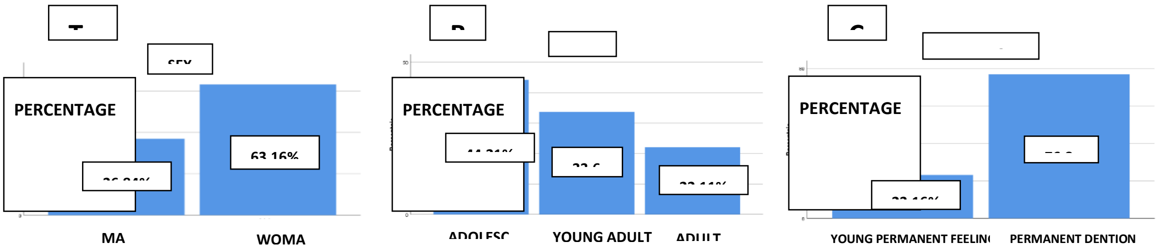


*Figure 1*

**Table 2**

*Cross-table of the diagnostic test with the Yonsei method in reference to the UPenn method (n=95)*

| | | UPenn **Reference Test** Discrepancy | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| Yonsei **Diagnostic Test** Discrepancy | Yes | 44 (59.5%) | 7 (33.3%) | 51 (53.7%) |
| | No | 30 (40.5%) | 14 (66.7%) | 44 (46.3%) |
| Total | | 74 (100%) | 21 (100%) | 95 (100%) |

Source: Own database

**Table 3**

*Discrepancy Frequency Detected with UPenn and Yonsei Techniques*

| | *UPenn (gs)* | | *Yonsei* | |
|---|---|---|---|---|
| Discrepancy | N° | Percentage | N° | Percentage |
| Yes | 74 | 77.9% | 51 | 53.7% |
| No | 21 | 22.1% | 44 | 46.3% |
| Total | 95 | 100.0% | 95 | 100.0% |

Source: Own database

**Tables 2 and 3** show the results of the diagnostic test of the Yonsei method in reference to the UPenn method, where the UPenn method determines the cross-sectional discrepancy in 74 Cone beam computed tomography, while in 21 of them it does not present such discrepancies. When compared with the Yonsei method, it is evident that of the 74 cases in which UPenn established discrepancies, with the Yonsei method it was possible to identify the (true positives = PV) in 59.5% (n=44). In the same way, in the 21 cases where UPenn did not detect cross-sectional discrepancy, with Yonsei's method it did so in 66.7% (n = 14) of the cases. (true negatives = VN).

**Table 4**

*Diagnostic characteristics of the Yonsei method (UPenn reference)*

| Diagnostic Features | Value | CI* (95%) | |
|---|---|---|---|
| Sensitivity (%) | 59.46 | 47.6 | 71.32 |
| Specificity (%) | 66.67 | 44.12 | 89.21 |
| Accuracy (%) | 61.05 | 50.72 | 71.38 |
| Predictive value + (%) | 86.27 | 75.85 | 96.7 |
| Predictive value - (%) | 31.82 | 16.92 | 46.72 |

*CI= Confidence interval

Source: Own database

Table **4** shows the diagnostic characteristics of the Yonsei technique, where the sensitivity calculation shows the proportion of patients with cross-sectional discrepancy, who were correctly detected by the technique, in this study it is 59.46% (95% CI 47.6%-71.32%). On the other hand, specificity gives us the proportion of patients without discrepancy, who were detected by the Yonsei technique, which was 66.67% (95% CI 44.12%-89.21%).

The Yonsei technique had a diagnostic accuracy of 61.05% (95% CI 50.72%-71.38%), which represents the probability that the result of the technique correctly predicts the presence or absence of discrepancy.

Likewise, the positive predictive value (PPV) indicates that there is an 86.27% probability (95% CI 75.85%-96.7%) that the patient presents the cross-sectional discrepancy, since the method has detected it.

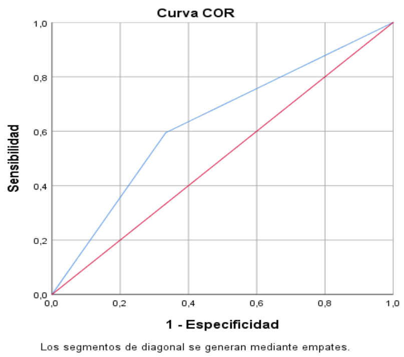


*Figure 2*. Ability to discriminate patients with and without transverse discrepancy according to area under the curve (AUC) with the YONSEI technique

Source: Own database

**Table 5**

*Area Under the Curve of YONSEI Technique*

Test Outcome Variables:

| Area | Desv. Error[a] | Asymptotic significance[b] | 95% confidence interval | |
|---|---|---|---|---|
| | | | Lower limit | Upper limit |
| 0.631 | 0.068 | 0.069 | 0.496 | 0.765 |

The test result variables: YONSEI have, at least, a tie between the positive real state group and the negative real state group. The statistics could be skewed.
to. Under the non-parametric assumption
b. Null hypothesis: true area = 0.5
Source: Own database

Figure 2 and Table 5 present the COR curve and the area under the curve (AUC) of the YONSEI technique, which was 0.631, which indicates the probability of correctly classifying a pair of randomly selected individuals with and without discrepancy (positive or negative).
It is usually accepted as an acceptable value of discrimination when it exceeds 0.700, this test having a lower value, being non-significant (p=0.069).
The axes of the ROC curve graph take values between 0 and 1, where the technique is considered non-discriminatory when the curve coincides with the reference or non-discrimination line, which has an AUC of 0.50. The closer the curve gets to 1, the greater its discriminative capacity.

**Discussion**

Achieving an adequate functional and static occlusal relationship is one of the primary objectives of orthodontic treatment. Consequently, it is imperative to make a diagnosis of malocclusions in all planes of space to achieve optimal occlusal stability.

In this study, Yonsei's technique demonstrated a sensitivity of 59.46%, indicating that approximately 60% of patients with transverse discrepancy were accurately diagnosed. Conversely, the technique's specificity was 66.67%, signifying that two-thirds of the patients without discrepancy were accurately classified. The overall diagnostic accuracy, defined as the technique's capacity to accurately predict the presence or absence of discrepancy, was 61.05%. Furthermore, the positive predictive value of the technique was found to be high, at 86.27%, suggesting that when the technique detected a discrepancy, it was highly probable that the patient actually had the condition.

The study indicates that the Yonsei method demonstrates superior accuracy and reliability in measuring cross-sectional discrepancy when compared with the UPenn method. This discrepancy can be attributed to the Yonsei method's utilization of a more precise reference, such as the distance between the CR and CR points. This reference has been shown to be associated with the location of the strength center of the first permanent molars (root bifurcation). The Yonsei method even makes mention of this association: According to Yun-Jin Koo et al., the CR is not easily affected by the simple tilting movement of a tooth. Conversely, as Tamburrino asserts, the UPenn method focuses on the distance between the maxillary edges.

The Yonsei method is employed due to its relative ease of execution, as evidenced by the Zhang study. This study compared the reliability of Andrews' element III analysis with that of the Yonsei method, concluding that the Yonsei cross-sectional analysis exhibited a CCI greater than 0.85. This finding indicates a higher degree of reliability in the measurement of maxillary and mandibular transverse width.

The present research is in accordance with the studies of Festilă D. et al., Barzallo S. and Vinicio E., as well as Heredia-Capote D. et al., which concur that the authors utilize the UPenn cross-sectional analysis as a reference because it is the most reliable analysis when performed in tomography. Conversely, Miner et al. established the Cone bean computed tomography. CBCT has been demonstrated to exhibit a high degree of precision in the measurement of maxillary widths, thereby substantiating its capacity to attain levels of sensitivity and specificity that exceed 85%.

Guerra A. et al. also conducted a study to determine the sensitivity and specificity of three diagnostic methods, including Ricketts posteroanterior analysis (PA), Hayes analysis in digital models, and UPenn analysis (CBCT). The findings of the study demonstrated that both CBCT and digital model analyses exhibited superiority over Ricketts' PA analysis with regard to "diagnostic sensitivity". The authors further indicated that, due to their high sensitivity and validity, Penn analysis and CAC model analysis can be considered the new gold standards for detecting cross-sectional discrepancies in CT scans. However, he does not contrast it with another tomographic analysis. Consequently, the present study subjects the UPenn analysis to an evaluation, as it is the most referenced, the most studied, and the most reproducible, and is examined with the Yonsei tomographic analysis.

With regard to the reliability of the methods, Guerra et al. have demonstrated that UPenn is a reliable method, exhibiting a sensitivity greater than 95.9% in comparison to other diagnostic methods. This indicates that it is capable of avoiding false negative diagnoses. In a similar vein, the Yonsei method exhibited a sensitivity of 59.46%, indicative of its diagnostic efficacy. This finding underscores the consistency and reproducibility of the results obtained by both methods.

These findings carry significant clinical implications, as they suggest that the Yonsei method may be more suitable for assessing maxillary transverse impairment in patients with dentofacial anomalies. Nevertheless, it is imperative to acknowledge that the selection of a methodology is contingent upon the particular circumstances of each case and the patient's individual requirements.

## Conclusions

The Yonsei tomographic analysis demonstrates a specificity of 66.67%, indicating that the analysis will accurately identify patients who do not exhibit a cross-sectional discrepancy.
The UPenn analysis demonstrated higher sensitivity compared to other studies, while the Yonsei analysis exhibited lower sensitivity. This indicates that the UPenn analysis has a greater capacity to identify true positive cases, that is, to diagnose patients with cross-sectional discrepancy in those who do have this pathology.
The Yonsei test demonstrates a diagnostic accuracy of more than 60%, thus indicating its capacity to accurately diagnose true positive and true negative cases.

The evaluation of diagnostic or disease screening tests necessitates the calculation of several key metrics, including sensitivity, specificity, positive predictive value, and negative predictive value. These measurements allow for the assessment of an analysis's capacity to accurately detect the presence or absence of a patient's cross-sectional discrepancy, which is imperative for decision-making in the planning and treatment of maxillary disjunction.
A standard of care based on the proper cross-sectional evaluation of patients has yet to be established. Some patients present with tomographic features that fall within normal parameters; however, they are afflicted with clinical maxillary atresia and require treatment in the form of maxillary disjunction.

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**Conflict of interest**
The authors declare no conflict of interest.

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**References**
1. McNamara, J. Maxillary transverse deficiency. *American Journal of Orthodontics & Dentofacial Orthopedics***117**, 567–570 (2000). doi: 10.1016/s0889-5406(00)70202-2.
2. VANARSDALL RL Jr. Transverse dimension and long-term stability. *Semin. Orthod.***5**, 171–180 (1999).
3. Heredia-Capote, D., Zalnieriunas-Montero, Á., Dommar-Pérez, B. & Falótico-Páez, G. Análisis de Penn para diagnóstico transversal. Serie de casos / Penn analysis for cross-section diagnosis. Case series. *OdousCientífica***25**, 2024 (2024).
4. Ye, G. *et al.* Comparative evaluation of transverse width indices for diagnosing maxillary transverse deficiency. *BMC Oral Health***24**, (2024). DOI: 10.1186/s12903-024-04580-4
5. Feştilă, D., Enache, A. M., Nagy, E. B., Hedeşiu, M. &Ghergie, M. Testing the Accuracy of Pont's Index in Diagnosing Maxillary Transverse Discrepancy as Compared to the University of Pennsylvania CBCT Analysis. *Dent J (Basel)***10**, (2022). DOI: 10.3390/dj10020023
6. Mullet J, C. A. F. I. S. P. Correlation between transverse maxillary discrepancy and the inclination of first permanent molars. A pilot study. *Revista Facultad de Odontología Universidad de Antioquia***28**, 354–373 (2017).DOI: https://doi.org/10.17533/udea.rfo.v28n2a8
7. Tamburrino, R. The Transverse Dimension: Diagnosis and Relevance to Functional Oclussion. *RWISO* 13–21 (2010).
8. Vinicio Egidio, B.-S. & María Gracia, O.-P. Proposal for the Analysis of The Transverse Diameter: Barzallo An-Bar Method. *Revista OACTIVA UC Cuenca***6**, 31–37 (2021). DOI: https://doi.org/10.31984/oactiva.v6i1.554

9. Zhang, C. xi *et al.* Reliability of 2 methods in maxillary transverse deficiency diagnosis. *American Journal of Orthodontics and Dentofacial Orthopedics***159**, 758–765 (2021). DOI: 0.1016/j.ajodo.2020.02.019

10. Lee, K. J., Choi, S. H., Choi, T. H., Shi, K. K. & Keum, B. T. Maxillary transverse expansion in adults: Rationale, appliance design, and treatment outcomes. *Semin Orthod***24**, 52–65 (2018). DOI:10.1053/j.sodo.2018.01.006
11. Chung, C. H. Diagnosis of transverse problems. *Semin Orthod***25**, 16–23 (2019). DOI:10.1053/j.sodo.2019.02.003
12. Eraydin, F., Cakan, D. G., Tozlu, M. & Ozdemir, F. Evaluation of buccolingual molar inclinations among different vertical facial types. *Korean J Orthod***48**, 333–338 (2018). DOI: 10.4041/kjod.2018.48.5.333
13. Guerra G, F. A. et al. Sensitivy and specificity of a radiographic, tomographic and digital model analysis for determining transverse discrepancies. *Revista Mexicana de Ortodoncia***6**, 28–34 (2018).
14. Krishnaswamy, N. R. Expansion in the absence of crossbite – rationale and protocol. *APOS Trends in Orthodontics***9**, 126–137 (2019).
DOI: 10.25259/APOS_115_2019
15. Ahn, J., Kim, S. J., Lee, J. Y., Chung, C. J. & Kim, K. H. Transverse dental compensation in relation to sagittal and transverse skeletal discrepancies in skeletal Class III patients. *American Journal of Orthodontics and Dentofacial Orthopedics***151**, 148–156 (2017). DOI: https://doi.org/10.1016/j.ajodo.2016.06.031
16. Anselmino, C. T. A. *Diagnóstico Precoz de La Estrechez Dell Maxilar Superior En La Dentición Mixta*. (2020). **ISSN:** 1514-9943
17. Herrero, R. R., Adanero Velasco, A. & Herrero, M. M. Diagnóstico de mordida cruzada posterior a partir del Wala ridge. (2020). ISSN: 1113-5181
18. Rodas Palacios, L. A. & Reinoso Quezada, S. J. Dimensión transversal mandibular en adultos Clase I esqueletal mediante tomografía de cráneo completo. *Anatomía Digital***5**, 147–160 (2022). DOI: https://doi.org/10.33262/anatomiadigital.v5i3.2209
19. García, M. Negative maxillary transverse discrepancy and cephalometric lateral differences according to the widht of upper arch. *Revista cubana de Estomatología* 58–64 (2021). ***versión On-line* ISSN 1561-297X**
20. Gurgel, J. & Pinzan-Vercelino, C. OPÇÕES DE TRATAMENTO PARA A DISCREPÂNCIA TRANSVERSAL DA MAXILA NO ADULTO. *Orthodontic Science and Practice***10**, 303–312 (2017). DOI: 10.24077/2017;1039-303312
21. Lee, K. J., Jeon, H. H., Boucher, N. & Chung, C. H. Transverse Analysis of Maxilla and Mandible in Adults with Normal Occlusion: A Cone Beam Computed Tomography Study. *J Imaging***8**, (2022).DOI: 10.3390/jimaging8040100
22. Kong, L., Liu, Y., Zhou, X., He, H. & Liu, Z. Responsiveness of three measurements in cone-beam computed tomography transverse analyses during both tooth-supported and mini-screw-assisted rapid maxillary expansion. *Angle Orthod***94**, 39–50 (2024). doi: 10.2319/031023-162.1
23. Miner, R. M., Al Qabandi, S., Rigali, P. H. & Will, L. A. Cone-beam computed tomography transverse analysis. Part I: Normative data. *American Journal of Orthodontics and Dentofacial Orthopedics***142**, 300–307 (2012). DOI: 10.1016/j.ajodo.2012.04.014

24. Miner, R. M., Al Qabandi, S., Rigali, P. H. & Will, L. A. Cone-beam computed tomography transverse analyses. Part 2: Measures of performance. *American Journal of Orthodontics and Dentofacial Orthopedics* **148**, 253–263 (2015). DOI: 10.1016/j.ajodo.2015.03.027
25. Cornejo, J. *et al.* Anatomical Engineering and 3D Printing for Surgery and Medical Devices: International Review and Future Exponential Innovations. *BioMed Research International* vol. 2022. https://doi.org/10.1155/2022/6797745
26. Ningbo, Z. *et al.* Qualitative and quantitative agreement research on three diagnostic methods for maxillary transverse discrepancy. *BMC Oral Health* **25**, 174 (2025). DOI:10.1186/s12903-025-05495-4
27. Koo, Y. J. *et al.* Maxillomandibular arch width differences at estimated centers of resistance: Comparison between normal occlusion and skeletal Class III malocclusion. *Korean J Orthod* **47**, 167–175 (2017). DOI: 10.4041/kjod.2017.47.3.167