Jagua Publication

*Healthcare Issues, 5(1):1–5, 2026. DOI: 10.58614/hi511*

**Healthcare Issues**

*Journal homepage: https://www.jpub.org/journal-details.php?journal-id=42*


***Research Article***

# Transverse Dental Adaptations Following Goshgarian-Type Transpalatal Arch Treatment: Direct and Indirect Intermolar Effect

**Ahmed Khamis Benomran** [1*]

[1]*Researcher at The Libyan Centre for Dental Research, Private Practice in Dentistry and Orthodontics, Consultant Orthodontist, Althager Orthodontic Centre, Misrata, Libya.*
[*]*Corresponding author: ahmedbenomran349@gmail.com*

## Article Info

***Keywords:*** *Inter-Molar Distance, Transpalatal Arch, Transverse arch control, Posterior dental crossbite.*

***Received:*** *01.02.2026;*
***Accepted:*** *23.02.2026;*
***Published:*** *04.03.2026*



## Abstract

This study investigates the biomechanical and clinical effects of the Goshgarian-type transpalatal arch (TPA) on inter-molar distances in patients with maxillary dental posterior crossbite. A sample of 100 patients was analyzed to enhance statistical reliability and clinical applicability. Results confirm the significant direct effect of the Goshgarian type TPA on maxillary first molars and the indirect effects on maxillary second molars and mandibular first molars. The thershold of 2.85 mm expansion of maxillary first molars required to obtain expansion of maxillary second molars is novel. Statistical analysis reveals that younger patients exhibit greater maxillary expansion, reinforcing the importance of early intervention. This study provides an in-depth discussion of anchorage control, long-term stability, and clinical biomechanics, highlighting the necessity for refined treatment protocols and future advancements in Goshgarian type TPA design and implementation.

## 1. Introduction

Posterior dental crossbite is a prevalent malocclusion affecting approximately 8-23% of individuals, particularly during early mixed dentition stages [1]. If untreated, posterior crossbite can result in asymmetrical jaw growth, functional shifts, and temporomandibular joint dysfunction [2]. Early diagnosis and intervention are crucial in ensuring proper occlusal development and minimizing long-term complications.

The trans-palatal arch (TPA) is a well-documented orthodontic appliance that serves multiple functions, including molar anchorage reinforcement, transverse arch control, and space maintenance [3] Introduced in 1972, it has been widely adopted due to its versatility in influencing maxillary dentition.

Biomechanically, the TPA exerts bilateral symmetric and asymmetric expansion forces, affecting not only the maxillary first molars but also the maxillary second molars and mandibular first molars through secondary forces transmitted via periodontal fibers [4]. However, the predictability of these indirect effects remains under-explored, prompting the need for further investigation into its broader clinical applications.

Several systematic reviews and meta-analyses confirm the efficacy of TPAs in anchorage control and expansion mechanics. Studies demonstrate that TPAs significantly contribute to molar expansion and anchorage in non-extraction orthodontic cases [5]. Despite these findings, limited literature exists regarding the TPA's indirect effects on mandibular molars and its influence on long-term treatment stability.

This study aims to provide a detailed assessment of the direct and indirect effects of the TPA on inter-molar distances, reinforcing its role in modern orthodontic treatment planning.

## 2. Methodology

### 2.1. Study Design & Sample

**Sample size:** 100 orthodontic patients, 42 males and 58 females, aged 11–26 years (mean: 15.61 $\pm$ 4.06 years).
**Inclusion criteria:** Patients with maxillary dental posterior crossbite undergoing orthodontic treatment.
**Exclusion criteria:** Patients with craniofacial anomalies, history of orthodontic treatment, or systemic conditions affecting bone metabolism.

### 2.2. Treatment Protocol

Each patient was treated using a custom Goshgarian-type TPA (0.9 mm Remanium hard wire, Dentaurum Co.) in conjunction with a maxillary fixed appliance Roth 0.022 Dentaurum. The appliance was bonded in the maxillary teeth only and no appliance on the mandibular teeth. The teeth included were the maxillary first molars to the maxillary first molars on the opposite side, the maxillary second molars were not included.

### 2.3. Measurements & Data Collection

Pre- and post-treatment inter-molar distances were measured on pre and post treatment dental stone study models using a digital Vernier gauge with high precision.

To insure reliability, pre and post treatment measurements were done by the author three times at two weeks interval and the mean value for each measurement was considered. The following measurements were taken Figure 1:

- a-Maxillary first molars IMD1 (pre treatment) & IMD2 (post treatment).
- b-Maxillary second molars IMD3 (pre treatment) & IMD4 (post treatment).
- c-Mandibular first molars IMD5 (pre treatment) & IMD6 (post treatment).

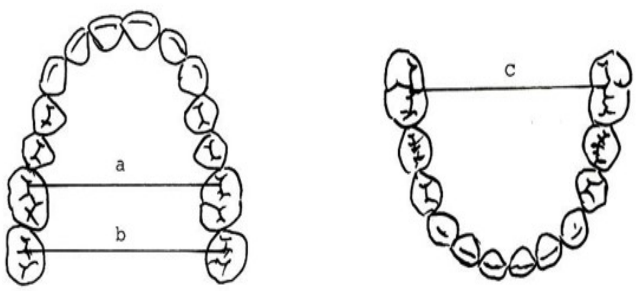


**Figure 1:** Different measurements

Statistical analysis was performed using SPSS 26.0 software (Statistical Package for Social Sciences) by IBM -USA. Statistical tests performed included:

- Paired sample t-tests for pre- and post-treatment comparisons.
- Pearson correlation analysis to assess relationships between age and treatment effects.

## 3. Results

There was no statistically significant difference between males and females, so data was pooled for further analysis.

### 3.1. Changes in Inter-Molar Distance (IMD) Following TPA Treatment

**Table 1:** Discriptive statistics and effect of TPA

| Measurment | Mean(mm) | S.D | Expansion Response | P-Value |
|---|---|---|---|---|
| IMD1-Pre | 42.28 | 4.02 | | |
| IMD2-Post | 47.05 | 3.53 | 4.99 | <0.0001 |
| IMD3-Pre | 48.94 | 3.90 | | |
| IMD4-Post | 50.53 | 3.76 | 1.59 | <0.0001 |
| IMD5-Pre | 45.37 | 3.41 | | |
| IMD6-Post | 45.94 | 3.55 | 0.58 | <0.0001 |

- **Maxillary 1st Molars:** Significant expansion ($p < 0.0001$) with a mean increase of 4.77 mm.
- **Maxillary 2nd Molars:** Indirect expansion observed ($p < 0.0001$) with a mean increase of 1.59 mm.
- **Mandibular 1st Molars:** Small but significant expansion ($p < 0.0001$) with a mean increase of 0.58 mm.

### 3.2. Correlation Between Age and Expansion Response

**Table 2:** Correlation between effects of TPA and age

| Effect of TPA-Age | Pearson Correlation (r) |
|---|---|
| IMD1-IMD2 | -0.165 |
| IMD3-IMD4 | -0.041 |
| IMD5-IMD6 | -0.105 |

Younger patients exhibited greater expansion at maxillary first molars (r = -0.165).
Minimal correlation between age and maxillary second molar expansion (r = -0.041).
Weak correlation between age and mandibular first molar expansion (r = -0.105).

From the results of the study, it appears that a minimum of 2.85 mm expansion response between maxillary first molars (IMD1-IMD2) is required to get an expansion of maxillary second molars (IMD3-IMD4).

## 4. Discussion

The present investigation provides statistically and clinically significant evidence supporting the transverse effects of the Goshgarian-type Trans-palatal Arch (TPA) on inter-molar distance. While the primary expansion at maxillary first molars (mean 4.77 mm) confirms the classical biomechanical expectations of the appliance, the secondary effects on maxillary second molars (1.59 mm) and mandibular first molars (0.58 mm) offer important insights into arch coordination and occlusal adaptation mechanisms.

### 4.1. Direct Maxillary First Molar Expansion

The significant increase in IMD1 ($p < 0.0001$) aligns with the original biomechanical principles described by Goshgarian [3], who emphasized the TPA's ability to control molar rotation and transverse dimension. Subsequent investigations have confirmed that TPA activation produces both buccal tipping and limited bodily movement depending on wire stiffness and activation magnitude [6–9].

Burstone and Koenig demonstrated that transverse molar movement depends on moment-to-force ratios generated by the palatal wire [6]. When fabricated with 0.9 mm stainless steel (as in this study), the appliance delivers sufficient rigidity to resist anchorage loss while allowing controlled transverse adaptation [7].

The magnitude of 4.77 mm observed here is clinically meaningful and comparable to slow maxillary expansion protocols in late mixed dentition [10–12]. Unlike rapid palatal expansion (RPE), which produces skeletal separation at the midpalatal suture [13], the TPA mainly induces dentoalveolar expansion in adolescents and adults [14]. This distinction is essential when planning treatment timing and predicting long-term stability.

### 4.2. Indirect Effects on Maxillary Second Molars

The 1.59 mm expansion in second molars supports the hypothesis of force transmission through transseptal periodontal fibers and arch coordination mechanisms [4, 15]. Although second molars were not directly engaged for active expansion, their positional change suggests redistribution of occlusal forces following first molar expansion.

Previous studies have shown that transverse expansion of anchor molars can induce spontaneous alignment and passive adaptation of adjacent teeth [16, 17]. However, the predictability of this effect remains variable and dependent on patient age, eruption stage, and periodontal adaptability [18].

The identified threshold expansion value of approximately 2.85 mm at first molars required to produce measurable second molar response is a clinically valuable contribution. This supports the biomechanical concept that a minimum displacement is required to overcome periodontal resistance before adjacent teeth demonstrate secondary adaptation [19].

### 4.3. Mandibular Molar Response and Occlusal Adaptation

The statistically significant yet modest 0.58 mm mandibular expansion deserves particular attention. Since no mandibular appliance was used, this change likely represents occlusal re-equilibration rather than direct orthopedic or orthodontic movement.

Functional occlusal adaptation has been described in posterior crossbite correction literature [2, 20]. Correction of maxillary constriction eliminates functional mandibular shifts, allowing spontaneous uprighting or lateral repositioning of mandibular molars [21]. Similar findings were reported in studies evaluating unilateral posterior crossbite correction, where mandibular arch width increased modestly after maxillary expansion [22, 23].

This phenomenon supports the theory that transverse discrepancies are often functional rather than purely skeletal, particularly in adolescents [24]. Therefore, the mandibular molar change observed in this study reflects neuromuscular adaptation rather than mechanical force application.

### 4.4. Age-Related Expansion Response

The weak negative correlation between age and maxillary first molar expansion (r = -0.165) reinforces the well-documented principle that younger patients demonstrate greater dentoalveolar adaptability [12, 25].

Growth-related transverse adaptability decreases after mid-palatal suture interdigitation progresses during adolescence [13, 26]. Although TPA expansion is primarily dentoalveolar, periodontal ligament cellular activity and bone remodeling potential are greater in younger patients [27].

This finding supports early interception of posterior crossbite, consistent with recommendations from pediatric orthodontic literature [28, 29]. Delayed treatment may result in increased tipping rather than bodily movement and potentially reduced stability [30].

### 4.5. Anchorage Control and Biomechanical Implications

Beyond expansion, the TPA serves as an anchorage reinforcement device. Literature consistently demonstrates that TPAs reduce mesial molar drift during space closure mechanics [31–33].

In Roth prescription systems (0.022 slot), anchorage control becomes critical when correcting transverse discrepancies simultaneously with sagittal mechanics [34]. The integration of a rigid TPA improves rotational control of maxillary molars, particularly in cases of mesiopalatal rotation commonly associated with Class II malocclusions [35].

The biomechanical stability provided by TPA may also contribute indirectly to the controlled and symmetrical expansion observed in this study.

### 4.6. Comparison with Alternative Expansion Modalities

When compared to Rapid Palatal Expansion (RPE), Mini-implant Assisted Rapid Palatal Expansion (MARPE), and Quad-Helix appliances, the TPA provides less skeletal expansion but greater simplicity and lower invasiveness [10, 13, 36].

RPE produces skeletal separation in growing patients but carries risks of relapse and soft tissue strain [37]. MARPE extends skeletal expansion potential into young adults but requires surgical or mini-implant placement [38]. Quad-Helix appliances generate continuous light forces but may produce more buccal tipping compared to rigid TPAs [39].

Therefore, the Goshgarian-type TPA occupies an important niche in mild-to-moderate transverse discrepancies where dentoalveolar correction is sufficient.

### 4.7. Stability Considerations

Long-term stability of dentoalveolar expansion remains a debated topic. Studies suggest that retention protocols significantly influence transverse stability [30, 40]. Expansion achieved primarily through tipping may relapse if not adequately retained [41]. Although this study did not include long-term follow-up, the moderate magnitude of expansion and use of fixed appliances may favor improved retention compared to removable expansion methods [42].

Future longitudinal research with $\geq$ 3–5 year follow-up is required to confirm stability trend.

Future research should integrate CBCT-based 3D analysis [43], finite element modeling to simulate stress distribution [44], and digital workflow integration using CAD/CAM fabricated TPAs [45].

Additionally, evaluating periodontal health outcomes during transverse expansion would enhance clinical safety data [46].

## 5. Conclusion

This study confirms that the Goshgarian-type TPA is a reliable and effective tool for managing posterior crossbite and molar expansion. Younger patients demonstrate greater adaptability, emphasizing the importance of early intervention. The appliance can affect teeth not connected to like maxillary second molars and even first molars in the opposite arch which can be beneficial to the patient and help in anchorage inforcement both in the maxillary and mandibular teeth. Future research should focus on long-term stability, CBCT validation, and biomechanical modeling for treatment optimization.

### Article Information

**Disclaimer (Artificial Intelligence):** The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

**Competing Interests:** Authors have declared that no competing interests exist.

## References

[1] R. A. Bell and R. R. LeCompte. Prevalence of posterior dental crossbite in children. *J Clin Orthod*, 15(7):452–425, 1981.

[2] E. Baldini and H. U. Luder. Functional shifts in posterior crossbite. *Eur J Orthod*, 4(1):15–21, 1982.

[3] G. H. Goshgarian. The trans-palatal arch. *Am J Orthod*, 61(3):132–139, 1972.

[4] P. Tsetsilas et al. Biomechanics of trans-palatal arch. *J Clin Orthod*, 49(9):557–563, 2015.

[5] S. Diar-Bakirly et al. Effectiveness of TPA: meta-analysis. *Orthod Sci Pract*, 16(2):45–58, 2017.

[6] C. J. Burstone and H. A. Koenig. Force systems in orthodontics. *Angle Orthod.*, 44:32–44, 1974.

[7] S. Braun et al. Transverse molar movement biomechanics. *Am J Orthod Dentofacial Orthop*, 107:200–208, 1995.

[8] B. U. Zachrisson. Molar rotation and transverse correction. *Am J Orthod*, 69:669–694, 1976.

[9] N. M. Cetlin and A. Ten Hoeve. Nonextraction treatment. *J Clin Orthod*, 17:396–413, 1983.

[10] A. J. Haas. Rapid palatal expansion. *Angle Orthod.*, 31:73–90, 1961.

[11] J. A. McNamara. Maxillary transverse deficiency. *Am J Orthod Dentofacial Orthop*, 117:567–570, 2000.

[12] T. Baccetti et al. Treatment timing for expansion. *Angle Orthod.*, 71:343–350, 2001.

[13] B. Melsen. Palatal suture growth study. *Acta Odontol Scand*, 33:55–67, 1975.

[14] C. S. Handelman. Nonsurgical RPE in adults. *Am J Orthod Dentofacial Orthop*, 111:146–156, 1997.

[15] K. Reitan. Tissue behavior in orthodontics. *Am J Orthod*, 46:881–900, 1960.

[16] W. R. Proffit et al. *Contemporary Orthodontics*. Elsevier, 6th edition, 2018.

[17] L. W. Graber et al. *Orthodontics: Current Principles*. Elsevier, 2016.

[18] S. E. Bishara and R. N. Staley. Maxillary expansion: clinical implications. *Am J Orthod Dentofacial Orthop*, 91:3–14, 1987.

[19] J. T. Hsu et al. Periodontal stress distribution study. *J Dent Res*, 86:278–282, 2007.

[20] B. Thilander. Crossbite and mandibular shift. *Eur J Orthod*, 6:25–34, 1984.

[21] I. Egermark et al. Functional crossbite adaptation. *Am J Orthod Dentofacial Orthop*, 97:503–11, 1990.

[22] J. Kurol and L. Berglund. Long-term crossbite correction. *Eur J Orthod*, 14:173–179, 1992.

[23] A. Lindner. Early crossbite correction outcomes. *Swed Dent J.*, 13:25–34, 1989.

[24] D. R. Myers et al. Functional posterior crossbite. *Pediatr Dent*, 2:13–17, 1980.

[25] L. Franchi et al. Skeletal maturation and expansion. *Angle Orthod.*, 74:343–350, 2004.

[26] F. Angelieri et al. Midpalatal suture maturation. *Am J Orthod Dentofacial Orthop*, 144:759–769, 2013.

[27] V. Krishnan and Z. Davidovitch. Cellular biology of tooth movement. Am J Orthod Dentofacial Orthop. *Am J Orthod Dentofacial Orthop*, 129(4):469.e1–32, 2006.

[28] American Association of Orthodontists. Early treatment guidelines. 2019.

[29] J. E. Harrison and D. Ashby. Orthodontic treatment timing. *Cochrane Database Syst Rev*, (2):CD001456, 2001.

[30] R. M. Little. Stability and relapse. *Semin Orthod*, 5:191–204, 1999.

[31] Nanda R. *Biomechanics and Esthetic Strategies*. Elsevier, 2005.

[32] I. Feldmann and L. Bondemark. Anchorage reinforcement review. *Angle Orthod.*, 78:123–128, 2008.

[33] Y. Kojima and H. Fukui. Anchorage mechanics analysis. *Am J Orthod Dentofacial Orthop*, 129:190–197, 2006.

[34] R. H. Roth. Functional occlusion philosophy. *J Clin Orthod*, 15:32–51, 1981.

[35] L. F. Andrews. Six keys to normal occlusion. *Am J Orthod*, 62:296–309, 1972.

[36] B. Wilmes and D. Drescher. MARPE concept. *J Clin Orthod*, 44:649–658, 2010.

[37] M. O. Lagravère and P. W. Major. RPE stability review. *Angle Orthod.*, 75:1046–52, 2005.

[38] W. Moon et al. Miniscrew-assisted expansion. *Am J Orthod Dentofacial Orthop*, 137:8–13, 2010.

[39] R. M. Ricketts. Quad-helix therapy. *Am J Orthod*, 68:246–256, 1975.

[40] J. A. McNamara and W. L. Brudon. *Orthodontic Retention*. Needham Press, 2001.

[41] P. A. Shapiro. Stability of expansion. *Am J Orthod*, 65:200–13, 1974.

[42] R. E. Moyers. *Handbook of Orthodontics*. Year Book, 1988.

[43] D. G. Garib et al. CBCT in orthodontics. *Am J Orthod Dentofacial Orthop*, 132:281–7, 2007.

[44] P. M. Cattaneo et al. Finite element orthodontics. *J Biomech*, 38:1343–51, 2005.

[45] T. J. Alford et al. CAD/CAM orthodontics. *Semin Orthod*, 23:66–74, 2017.

[46] WennstromJl. Periodontal response to orthodontics. *EUJ Orthodontics*, (18):1–9, 1996.