Review Article

University J Dent Scie 2022; Vol. 8, Issue 4

# Transpalatal Arch and its Modifications

**Abstract::**
Versatility has become key feature for an appliance to be chosen for any orthodontic treatment, one such appliance is transpalatal arch (TPA) which has numerous advantages while using in fixed orthodontic treatment. TPA not only provides additional anchorage but also used for active movement of individual teeth. The aim of this article is to present a broad review of the literature by including various modifications of TPA and their indications, to better assist the clinician for using it in different case

**Key-words:** Transpalatal arch, Goshgarian appliance. anchorage, molar distalisation, expansion, scissor bite.

## Introduction:

## Historical Background:

TPA was first introduced by Robert A. Goshgarian of Waukegan, Illinois in 1972[1]. Since then transpalatal arch (TPA) is a commonly used appliance for anchorage in the maxillary arch and for controlling the position of the molars. Transpalatal arch has traditionally been used as a soldered, passive orthodontic appliance. The removable TPA, also known as the Palatal Arch Bar or Transpalatal Lingual Arch has more versatile treatment applications.[2,3]

The transpalatal arch (TPA) is fabricated from a stainless steel wire which spans the palate and connects bands on both maxillary first permanent molars. Later, its other modifications are also fabricated by Titanium Molybednum alloy (TMA) wire. TPA is an auxiliary appliance, which is used for controlling the position of maxillary molars, controls the rotation of maxillary molars and uprighting, stabilization of posterior transverse dimensions during treatment, and maintenance of leeway spaces during the transition of the dentition.[4]

## Introduction:

TPA is most commonly used to control the anchorage in upper arch. It is either a prefabricated or an individually prepared removable TPA is used and placed in tubes on the palatal side of the molar bands.It is of two main types 1) Removable TPA and 2) Soldered TPA.

## Various modifications of TPA over the years

### 1) The Goshgarian Appliance/Transpalatal arch

It was the first and original design of TPA, which was fabricated with Stainless steel wire extending across the palate with omega loop in the middle.

## Parts:

1) A Coffin loop or Omega loop
2) Wire adapted along the curvature of palatal shelves on both the sides.

TPAs are routinely used during treatment in both permanent and mixed dentition to [5]

1. Stabilise and maintain arch widths;
2. Correction of molar rotation
3. Control eruption of upper molars;

**[1]ISHA AGGARWAL, [2]PALLAVI VISHAVKARMA, [3]SANJAY MITTAL, [4]TANZIN PALKIT, [5]MERRY**
[1-5]Bhojia Dental College Baddi, Distt Solan Himachal Pradesh

**Address for Correspondence:** Dr. Pallavi Vishavkarma Bhojia Dental College Baddi, Distt Solan Himachal Pradesh Email : pallavivishavkarma01@gmail.com

**Received :** 20 August, 2022, **Published :** 31 Dec., 2022

**How to cite this article:** Pallavi, P. V., Isha Aggarwal, Sanjay Mittal, Tanzin Palkit, & Merry. (2022). Transpalatal Arch and its Modifications. UNIVERSITY JOURNAL OF DENTAL SCIENCES, 8(4).

Access this article online

Website: www.ujds.in

Quick Response Code

DOI: https://doi.org/10.21276//ujds.2022.8.4.22

4. Correct molar crossbites for maxillary expansion and buccal root torque; and
5. Correct asymmetries mesiodistally[5]

## Fabrication:

According to Spena (2002) [6], six bendings may be required and three of them are obligatory (to adapt to the form of the palate, to adapt to the torque of the molars, and to adapt to the rotation of the molars). The other three are needed in some of the cases: bending the end of the TPA, which will be held with the pliers, so that it does not traumatise the palatal mucosa and does not irritate the tongue; bending in cases of thick palatal mucosa; and bending according to the sagittal curvature of the palate.

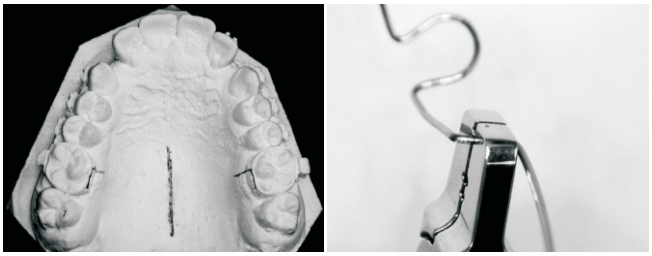

Fig 1a: Plaster model for TPA fabrication Fig 1b: Bending of wire at the width of plier

Fig. 2: Goshgerian TPA

2.Burstone lingual arch Burstone and Koenig in 1981[7] introduced transpalatal lingual arch to bring molar corrections in first, second and third order movements.

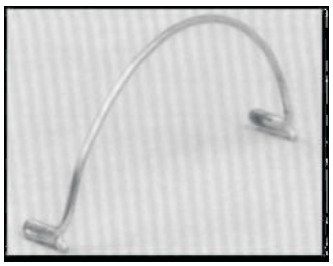

Fig. 3: Burstone lingual arch

3.Zachrisson type transpalatal bar Zachrisson-type transpalatal bar introduced in 1997[8] which is made from a (0.9 mm) Blue Eligiloy wire, and consists of three loops: a larger and longer mesially directed central loop and on either side two small, distally directed loops. Less or no reactivation is required due to lower load deflection rate.This modification of TPA had lower horizontal contractive forces as compared to Goshgarian TPA

Zachrisson (2004)[9] describes the preparation of a modified custom-made TPA with two additional loops next to the Coffin loop on a plaster model that includes the molar bands,So for this reason adjusted bands are placed in impression. In cases of asymmetrical palate it can also be altered, according to the position of the palatal tubes, during the adjustment of the bands.

Disadvantage to both the clinician and the patient is that with this type of TPA, the bands must be removed after taking the impression and recemented after preparing the TPA. This is potentially uncomfortable for the patient and time-consuming for the clinician. Taking into consideration the widespread use of TPA adjusted in palatal tubes of the molars to achieve sagittal [3,6] and vertical [10,11] effects aswell rotation control of the molars [5].

Fig 4: Zacchrison Type TPA

4.Wallis &Vasir modification of TPA Wallis & Vasir in 1998[12] introduced a simple method of attachment for Transpalatal Arch by passing the wire distal to the most posterior molar which enters the headgear tube mesially. This modified appliance being more flexible than its standard counterpart produced lighter forces and couples thus enabling greater precision for horizontal expansion and molar angulation.

Fig 5: Wallis and Vasir modification

5. Combination of Goshgarian arch & Nance button J.M. Cobo et al in 1998[13] modified Goshgarian arch by combining it with Nance button. This modification is

indicated to maintain anchorage while retracting anterior teeth after molar distalization

Fig. 6: Combination of Goshgerian and Nance palatal button

6.Tongue friendly TPA Michael Hudson in 2000 [14]introduced tongue friendly transpalatal arch simply by filling the loop with acrylic to prevent deep grooves on patients tongue(Figure 6). Indicated in cases requiring vertical anchorage preparation, where TPA is placed 5-6mm away from palate, to facilitate molar intrusion.

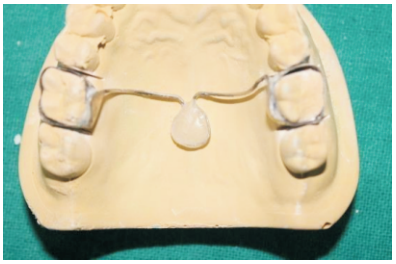

Fig. 7: Tongue Friendly TPA

7. TPA for Asymmetric distalization of molars Massimiliano Mandurino, Laura Balducci in 2001[15] introduced transpalatal arches fabricated from TMA wire for asymmetric distalization of molars (Figure 8). This type of TPA is inserted from two different directions, distal into tube of the maxillary molar used as anchorage and from mesial into tube of the maxillary molar that has to be distalized. On activation the transpalatal arch applies mesiobuccal rotation to anchor molar and distally directed force to the opposite molar.

Fig . 8: TPA for Assymetric molar distalisation

8. TPA with helices Horacio Garcia-Rojas Guerra in 2002[16] modified transpalatal arch by incorporating two helices adjacent to omega loop, such that the appliance can correct molar rotations while providing anchorage and torque control. Incorporation of two helices increase flexibility and working range of transpalatal arch.

Fig. 9: TPA with helices (2002)

9. Keles TPA Ahmed Keles in 2003[17] introduced an easy, effective, and precise method of correcting molar rotation. This type was fabricated using square beta-titanium alloy wires (TMA; Ormco) instead of round stainless steel wires and hinge cup attachments were use instead of palatal sheath .

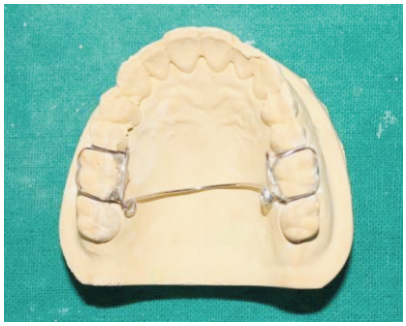

Fig. 10: Keles TPA (2003)

10. Bonded TPA Garri T sibel, Mladen M. Kuftinec in 2004[18] introduced bonded Transpalatal arch. Fabrication was done by sending the patient's cast in laboratory for construction of bondable pads. These pads must be wide, closely confirmed to the lingual surfaces of the molars, and microetched – all of which contribute to optimal retention and bond strength .

Fig. 11: Bonded TPA

11.Miniscrew-Assisted TPA Hyun Sang Park in 2006[19] introduced Miniscrew-Assisted Transpalatal Arch for use in Lingual Orthodontics to improve anchorage control for retraction of the upper anterior teeth, using single mini screw. The posterior arrangement of palatal mini-screw allows minor tip back or distal crown movements on molars

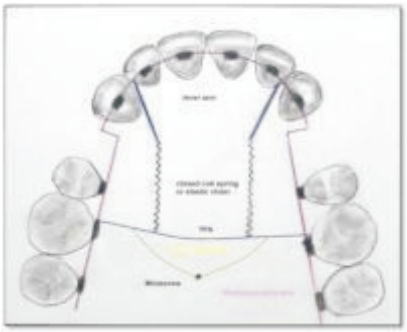

Fig. 12: Miniscrew assisted TPA

12. Atraumatic Transpalatal arch Valentin Moutaftchie, Alexander Moutaftchiev [20] in 2009 introduced individually prepared atraumatic Transpalatal arches, which considers the position of the palatal TPA tubes thus avoids the need for molar bands removal and placing them in a plaster model.

Fig. 13: Atraumatic TPA

13. Fibre reinforced composite TPA Pizzoni in 2010[21] fabricated a fibre reinforced composite TPA for patients demanding esthetics and was used as an anchorage device bonded to molars and premolars to orthodontically align impacted maxillary canine using a palatal cantilever

Fig14: Fiber reinforced TPA

14. M-TPA with customized bonding base M. Fujisawa & A. Komori [22]in 2011 modified TPA (MTPA) by customizing bonding base, whichcan be directly bonded using resin-reinforced glass ionomer cement. MTPA provides a tight fit as it contacts large area. MTPA can be removed as per anchorage requirements without disturbing labial fixed appliances as it is bonded on lingual side.


Fig. 15: Modified TPA with coustomised bonding base

15. Individually prepared TPA Vijay Reddy, Mrajesh Reddy, Mrenu Parmar in 2012[23] modified transpalatal arch for correction of scissor bite in contrast to cross elastics which requires patient co operation and generate extrusive forces on both upper and lower molars causing bite opening and premature posterior contacts, with consequent clockwise rotation of the mandible .

Fig. 16: Individually prepared TPA

16. TPA for scissor bite correction Sujala D, K Nagaraj in 2012[24] modified Transpalatal arch for molar intrusion.Fabricated from 0.36" stainless steel wire, it had extended palatal arm where an intrusion of second molar is required. Buccal arm was soldered on buccal aspect of first molar. Appliance activation is done by stretching an elastomeric chain from extended palatal arm to buccal aspect of molar to be intruded which generates 50gm of force .

Fig. 17: TPA for scissor bite correction

17. TPA for molar intrusion Lee et al in 2013[25] fabricated miniscrew supported TPA to reinforce anteroposterior and vertical anchorage of the maxillary posterior teeth. Two miniscrews were placed 5- 8mm apart in the midpalatal suture

area and were connected with modified transpalatal arch (M-TPA) using ligature wires. Intrusion was performed with elastomeric chains or ligature wires from the horizontal ligature wire to the stabilization hook of the modified transpalatal arch.


Fig. 18: Modified TPA

18. TPA proclination spring Paduano S, Spagnuolo G, Biase Gd, Cioffi I. in 2013[26] modified TPA by incorporating NiTisuperalastic coil springs and push rods which extends on the upper central incisors for correction of a Class II division 2 incisors. It is activated by locking the soldered screws with a custom made screwdriver

Figure 19: Modified Transpalatal Arch Proclination spring - 2013

19. Tongue friendly TPA Gupta A, Kannan S., Gupta G., Goyaliya A. Kaul A., Garg N. in 2013[27] modified Transpalatal arch by covering it with an arch wire sleeve of 0.031" internal diameter to prevent discomfort to the patient's tongue, where TPA is used for molar intrusion.

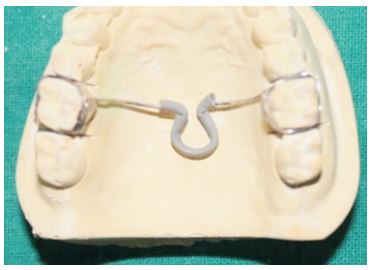

Fig. 20: Modified Transpalatal Arch with archwire sleeve - 201320.

20. Butterfly Arch Alireza Nikkerdar in 2013[28] introduced butterfly arch to overcome the disadvantages of TPA. It is an intra-oral appliance, extending from one side of the upper posterior teeth to the other side to maximize the efficacy of controlling the position of maxillary posterior teeth in all three planes of space. The unique shape of the butterfly arch withstands the mesially directed forces with a mechanism that puts strain on a stiff wire along its long axis.

Fig. 21: Butterfly TPA.

21. TPA for molar intrusion Kumar ND et al [29]modified transpalatal arch for molar intrusion using 0.036″ elgiloy or stainless steel wire which extended from the molar to molar with a"U"loop on either side of the arm. The "U" loops are constricted to keep the transpalatal arch away from palatal tissue.

22. TPA for bucally placed 2nd maxillary molar Mehta F, Patel R, Kharadi L, Mehta S modified TPA in 2014[30] for Correction of bucally Placed Maxillary 2nd Molars using middle loop which was directed distally and two additional loops directed mesially for engaging e-chain.

## Fabrication:

A Modified TPA is made of 1.0 mm hard stainless steel round wire with middle loop directed distally and two additional loops directed mesially (4 mm long and 1.5 mm wide),symmetrically positioned on either side of the middle loop at the bisecting point of the middle third (mesiodistal) of maxillary lateral incisor and mesial surface of maxillary 1st molar, adapted along the palatal curvature approximately 2 mm away from the palatal tissues. It is then soldered on the first molar bands. This assembly is cemented on the maxillary 1st molars. These additional two loops on the Modified TPA is used for engaging an E- chain.[31,32,33]

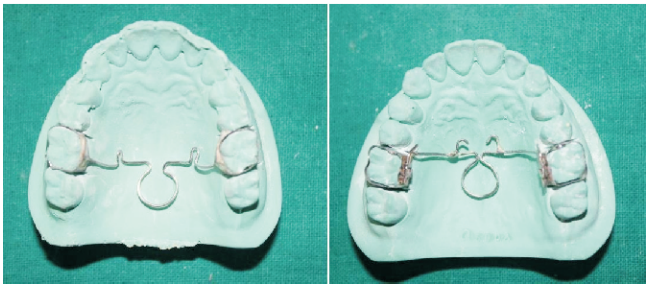

Fig. 22: Modified Transpalatal arch for correction of bucally placed 2nd molars - 2014

22. TPA for bilateral molar intrusion Hassan S, Shah MJ in 2014[34] modified TPA for intrusion of bilateral maxillary molars which was fabricated by banding the second premolars and second molars bilaterally, that are connected both buccally and palatally. Small U-loop is incorporated at the centre of the molars both buccally and palatally to which e-chain was connected .

Fig. 23: Modified Transpalatal arch for bilateral molar intrusion - 2014

24. Asymmetric TPA for molar intrusion Riddhi, Prasad S in 2015[35,36] modified TPA with asymmetric arms for intrusion of molar (mTPA). The shorter arm was engaged to the palatal sheath of the molar to be intruded, so that the appliance lies at 4 mm from palate.

Fig. 24: Asymmetrical Transpalatal arch - 2015

25.TMA-TPA Tsetsilas M et al in 2015[37]fabricated TPA using titanium molybdenum alloy (TMA) and fitted with 0.032" x 0.032" Burstone lingual brackets for symmetric and asymmetric expansion of molars .

Fig. 25: TMA -TPA

26. Mini-implant aided TPA Miresmaeilia A et al in 2015[38] used mini-implant-aided TPA with a horseshoe shaped palatal bar inserted in the palatal sheath, and two mini screws between the 1st molar and 2nd premolar for molar distalization. A traction force is exerted from the anterior helix to the mini screws.

Fig. 26: Mini implant aided Transpalatal arch for molar distalization – 2015

27. M shaped palatal arch 2017 Kapadia RM in 2017[39] introduced M-shaped palatal arch which has three loops; one center loop and two compensatory loops for bilateral molar scissor bite correction .

Fig. 27: M shaped palatal arch 2017

28.Transpalatal arch for expansion 2017 Thomas A et al in 2017[40] modified removable type TPA with bilateral helix and bilateral wire extending on the palatal surfaces of premolars and canine teeth for expansion. Activations were done by opening the helix with a bird beak plier.

Fig. 28: Transpalatal arch for expansion – 2017

29. Modified TPA-supported removable pontic Missing posterior teeth or necessary asymmetric orthodontic extraction may lead to migration, tilting of the adjacent teeth, and supra-eruption of the opposing teeth along with compromised esthetics. This may contribute to disruption of the occlusion which makes orthodontic tooth movement more difficult. A removable pontic with modified TPA is a verysimple and easy to fabricate and can be useful in daily adult orthodontic practice. It acts as an esthetic pontic requiring no bracket attachment.[41,42,43,44]

## Advantages:

1. Ease of maintaining oral hygiene.
2. Providing controlled anchorage, and preventing supra-eruption of opposing teet

It gains retention by the slightly expanded fiexible TPA which is compressed while inserting in the mouth. Secondary retention is gained by the snug fit with adjacent teeth. It can be used unilaterally as the expanded TPA and the acrylic extension over the interdental area of opposite side posterior teeth helps in holding the appliance in place.

## Fabrication:

1. Armamentarium: 20-gauge, round TMA wire for TPA (to increase fiexibility and springiness), cold cure acrylic and acrylic teeth.
2. Modified TPA is fabricated 1 mm away from palatal surface and 2-3 mm below the gingival margin of both sides.
3. Select acrylic teeth of proper size and shape as pontic.
4. Stabilize TPA and pontic on the cast, followed by acrylization with the acrylic extension 4-5 mm below the gingival margin.
5. Finally, trimming and polishing is done.
6. Insertion of the Modified TPA-supported removable pontic in the unesthetic extraction space.

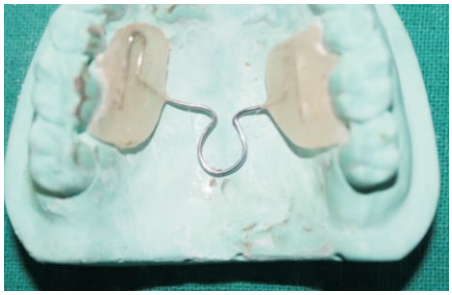

Fig. 29: Pontic TPA

## Discussion:

Apart from innovations, transpalatal arch was studied for its effectiveness in conservation of anchorage and in its other uses. A Dahlquist et al studied effect of TPA on first molar rotation and it was found that transpalatal arch is effective in derotation of maxillary first molar accompanied by a slight expansion in majority of cases. A large derotation results in contraction [44].According to Braun application of TPA can gain 2.1mm of arch length as it can exert a distal force which is equivalent to maxillary 1st molar centre of resistance [45]. (1997) Effect of the TPA during extraction treatment was studied by H.

Zablocki et al in 2008. The results of this study indicated that TPA has no significant effect on either the anteroposterior or vertical position of the maxillary first molars during extraction treatment & alternative methods like microimplants should be considered in cases where absolute anchorage is desired [4].

In a comparison study between mini-screw implant and transpalatal arch by Liu YH, Liu J it was found that miniscrew implant could not only retract the upper incisors but also slightly intrude upper incisors and upper molars [46]. A randomized clinical trial (RCT)was conducted to compare the efficacy of Goshgarian TPA and Nance palatal arch by N. Stivaros et al in 2010.This RCT did not support any preference over the use of the Goshgarian TPA or Nance palatal arch, although Goshgarian arch was considered significant due to slightly reduced patient discomfort [47].

## Conclusion:

Understanding the basic biomechanics of any orthodontic appliance is important to understand the variety of treatment options possibleusing the appliance. Hence through this article a clinician can wisely select modification of TPA as per requirement and effectively use it in orthodontic treatment after thorough understanding of its basic biomechanics.

Missing posterior teeth or necessary asymmetric orthodontic extraction may lead to migration, tilting of the adjacent teeth, and supra-eruption of the opposing teeth along with compromised esthetics. The modified TPA supported removable pontic acts as an esthetic pontic during orthodontic space closure.

## References:


1. Goshgarian RA. Orthodontic palatal arch wires. United States Government Patent Office; 1972.
2. Burstone CJ, Manhartsberger C. Precision lingual arches-Passive appiications. J Clin Orthod 1988;22: 444-451.
3. Burstone CJ. Precision lingual arches- Passive Active applications. J Clin Orthod 1989;23:101-109.
4. McNamara JA Jr, Brudon WL. Orthodontics and dento facial orthopedics. Ann Arbor, Mich: Needham Press; 00202001.
5. Gunduz E, Zachrisson BU, Honigl KD, Crismani AG, Bantleon HP. An improved transpalatal bar design. Part I. Comparison of moments and forces delivered by two bar designs for symmetrical molar derotation. Angle Orthod 2003;73:239-43.
6. Spena R. Nonextraction Treatment: An Atlas on Cetlin Mechanics. Birmingham, AL: GAC International, 2002; pp19- 72.
7. Burstone CJ, Koenig HA. Precision adjustment of the form arch arch: transpalatal lingual computer predetermination. Am J Orthod 1981;79:115-34.
8. Zachrisson, B. U. Important aspects of long-term stability. J ClinOrthod 1997. 31:562–583.
9. Zachrisson BU. Clinical use of custom-made transpalatal arches—why and how. *World Journal of Orthodontics* 2004; **5**(3): 260-267.
10. Deberardinis M, Stretesky T, Sinha P, Nanda RS.Evaluation of the vertical holding appliance in treatment of high-angle patients. *American Journal of Orthodontics and Dentofacial Orthopedics* 2000; **117**(6): 700-705.
11. Wise JB, Magness WB, Powers JM. Maxillary molar vertical control with the use of transpalatal arches. *American Journal of Orthodontics and Dentofacial Orthopedics* 1994;**106**(4): 403-408.
12. C. Wallis, N. S. Vasir. A Simplified Method of Attachment for the Quadhelix and Transpalatal Arch. British Journal of Orthodontics. 1998; 25:263–267.
13. J.M. Cobo, B. Diaz, F.de Carlos. Maintaining anchorage with a combination Nance-Goshgariantranspalatal arch. Journal of clinical orthodontics .1998; 32(11):681.
14. Hudson JM. Tongue-friendly transpalatal arches. JClinOrthod 2000, 34(11):671.
15. Massimiliano M, Laura B. Asymmetric Distalization with a TMA Transpalatal Arch. J ClinOrthod, 2001, 35(3):175.
16. Guerra H. A Modified Transpalatal Arch. J ClinOrthod. 2002;36(4):210.
17. A. Keles. An effective and precise method for rapid molar derotation: Keles TPA. World J Orthod 2003; 4(3):1-8.
18. Tsibel G, Kuftinec M. A Bonded Transpalatal Arch. J ClinOrthod. 2004;38(9):513.
19. Park HS. A Miniscrew-Assisted Transpalatal Arch for Use in Lingual Orthodontics. J ClinOrthod. 2006; 40(1):12.
20. V Moutaftchiev, AMoutaftchiev. The Individually Prepared Transpalatal Arch (TPA). OHDMBSC 2009; 8(1):13.
21. Pizzoni L. Fibre reinforced composite transpalatal arch in impacted canine orthodontic treatment. ProgOrthod. 2010;11(1):83-5.
22. Fujisawa, Masato & Komori, Akira. (2011). A modified transpalatal arch with customized bonding base. Orthodontic Waves. 2011; 70. 39-42.
23. V. Reddy R. Parmar R. A Modified Transpalatal Arch for Correction of Scissor Bite. J ClinOrthod. 2012; 46(5):308.
24. Durgekar S, Nagaraj K. Modified Transpalatal Arch For Molar Intrusion. J IndOrthod Soc. 2012; 23(3).
25. Lee J, Miyazawa K, Tabuchi M, Kawaguchi M, Shibata M, Goto S. Midpalatalminiscrews and high-pull headgear for anteroposterior and vertical anchorage control: cephalometric comparisons of treatment changes. Am J OrthodDentofacialOrthop. 2013;144:238–250.
26. Paduano S, Spagnuolo G, BiaseGd, CioffiI.Treatment of a Class II Division 2 Patient with Severe Skeletal Discrepancy by Using a Custom Made TPA Proclination Spring. Open Dent J. 2013; 20;7:109-17.
27. Gupta A, Kannan S, Gupta G, GoyaliyaA,Kaul A, Garg N. A Modified Transpalatal Arch with Sleeve. J IndOrthodSoc 2013; 47(2):112.
28. Nikkerdar A. Butterfly Arch: A Device for Precise Controlling of the Upper Molars in Three Planes of Space. J Dent (Tehran). 2013; 10(3): 221–226.

29. Kumar ND, Krishna BR, Shamnur N, Mithun K. Modified transpalatal arch for molar intrusion. J Int Oral Health 2014;6(6):88-9.
30. Mehta F, Patel R, Kharadi L, Mehta S. A Modified Transpalatal Arch for Correction of Bucally PlacedMaxillary 2nd Molars: Non-Compliant Mechanics. Journal of Dental and Medical Sciences 2014;13(4)24-26.
31. Gupta A, Kannan S, Gupta G, Goyaliya A, Kaul A, Garg N. A Modified Transpaltal Arch With Sleeve. J IndOrthodSoc 2013;47(2):112.
32. ElifGündüz, A. G. Crismani, H. P. Bantleon, Klaus D. Hönigl, and Bjorn U. Zachrisson (2003) An Improved Transpalatal Bar Design. Part II. Clinical Upper Molar Derotation— Case Report. The Angle Orthodontist: June 2003, Vol. 73, No. 3, pp. 244-248.
33. Zablocki HL1, McNamara JA Jr, Franchi L, Baccetti T. Effect of the transpalatal arch during extraction treatment. Am J Orthod Dentofacial Orthop. 2008 Jun;133(6):852- 60. doi: 10.1016/j.ajodo.2006.07.031.
34. Hassan S, Shah MJ. Bilateral Intrusion of Molar using Modified Transpalatal Arch in Mutilated Case. J IndOrthodSoc 2014;48(4):280-281.
35. Riddhi, Prasad S. Molar intrusion with asymmetrical MTPA. International Journal of Oral Health Dentistry, October – December 2015;1(4):190-193.
36. Lyka I, Carlsson GE, Wedel A et al: Dentists' perception of risks for molars without antagonists. A questionnaire study of dentists in Sweden, Swed. Dent. J. 25:67-73, 2001.
37. Tsetsilas M. Konermann AC. Keilig L. Reimann S. Jager A. Bourauel C. Symmetric and asymmetric expansion of molars using a Burstone type transpalatal arch. Biomechanical and chemical analysis.. J OrofacOrthop 2015 Sep;76(5):377-90
38. Miresmaeilia A, Sajedia A, MoghimbeigicA.Farhadiana N. Three-dimensional analysis of the distal movement of maxillary 1st molars in patients fitted with mini-implantaided trans- palatal arches. Korean J Orthod 2015;45(5):236-24429.
39. Kapadia RM. A simple and effective appliance for correction of bilateral molar scissor bite: “The M-shaped palatal arch”.Int J OrthodRehabil 2017;8:125-7.
40. Thomas A, Afshan T, Deru T. Modification of transpalatalarch for expansion. J Indian OrthodSoc 2017;51:289-90
41. Profitt WR. Contemporary Orthoodntics. 4th ed. United States: Mosby; 2007.
42. Graber TM, Vanarsdall RL, Vig KL. Orthodontics current principles and techniques. 4th ed. St. Louis: The CU Mosby Company; 2005.
43. Jain AK, Ganeshkar SV, Revankar A. Modifi ed TPA-supported removable pontic. APOS Trends Orthod 2014;4:76-7.
44. Dahlquist A, Gebauer U, Ingervall B. The effect of a transpalatal arch for the correction of first molar rotation. Eur J Orthod. 1996; 18(3):257–267.
45. Braun S, Kusnoto B, Evans C. The effect of maxillary molar derotation on arch length. Am J OrthodDentofacialOrthop 1997; 112(5):538–44.
46. Liu YH, Liu J, Li Q, Ding WH.An efficacy comparison between mini-screw implant and transpalatal arch on dentofacial morphology in extraction cases. Chinese Jour of Somatology. 2009; 44(8):454-9.
47. Stivaros N, Lowe C, Dandy N, Doherty B, Mandall N. A randomized clinical trial to compare the Goshgarian and Nance palatal arch. Eur J Orthod. 2010; 32(2):171-176.