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Review Article

Transpalatal Arch: An Overview of Literature

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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 broadreview of the literature by including various modifications of TPA and their indications, to better assist the clinician for using it in different cases.

Key words: Orthodontics; Transpalatal arch; Goshgarian arch; Transpalatal arch modifications.

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BACKGROUND

Over the years, transpalatal arch has served in maintaining treatment success by providing anchorage in its simple and modest form. Introduced by Robert A. Goshgarian of Waukegan, Illinois in 1972, since then it has been an integral component of fixed appliance therapy[1].The transpalatal arch (TPA) is fabricated from a stainless steel wire which spans the palate and connects bands on both maxillary first permanent molars. This auxiliary appliance is used to change or stabilize the position of the maxillary molars in all dimensions.It can be also used for correcting molar rotation and uprighting, stabilization of posterior transverse dimensions during treatment, and maintenance of leeway spaces during the transition of the dentition[2].

This article aims to review transpalatal arch and its various modificationstill date and their respective indications, so as to aid a clinician to select a specific appliance modification for a given case.

1.The Goshgarian Appliance/Transpalatal arch

The original design included a straight bar made from 0.036-inch stainless steel wire extending across the palate with a loop in the midline. (Figure1).

TPAs are routinely used during treatment in both permanent and mixed dentition to [3]:

1. Stabilise and maintain arch widths;
2. Correction of molar rotation;
3. Control eruption of upper molars;
4. Correct molar crossbites for maxillary expansion and buccal root torque; and
5. Correct asymmetries mesiodistally [3].

Modifications of Transpalatal Arch

2. Burstone lingual arch.

Burstone and Koenig in 1981 introduced transpalatal lingual arch to bring molar corrections in first, second and third order movements [4]. (Figure 2)

3.Zachrisson type transpalatal bar.

Figure 3 is a occlusal representation of Zachrisson-type transpalatal bar introduced in 1997 which is made from a 0.036-inch (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 [5].

4.Wallis &Vasir modification of TPA

Wallis &Vasir in 1998 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 [6]. (Figure4)

5.Combination of Goshgarian arch & Nance button
J.M. Cobo et al in 1998 modified Goshgarian arch by combining it with Nance button. This modification is indicated to maintain anchorage while retracting anterior teeth after molar distalization [7].(Figure 5)

6. Tongue friendly TPA
Michael Hudson in 2000 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 [8].

7. TPA for Asymmetric distalization of molars
MassimilianoMandurino, Laura Balducci in 2001 introduced transpalatal arches fabricated from TMA wire for asymmetric distalization of molars (Figure 7). 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 thetranspalatal arch applies mesiobuccal rotation to anchor molar and distally directed force to the opposite molar [9].

8. TPA with helices
Horacio Garcia-Rojas Guerra in 2002 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(Figure 8). Incorporation of two helices increase flexibility and working range of transpalatal arch [10].

9.Keles TPA
Ahmed Keles in 2003 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 [11]. (Figure9).

10. Bonded TPA
GarriTsibel, Mladen M. Kuftinec in 2004 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 [12].(Figure 10)

11.Miniscrew-Assisted TPA
Hyun Sang Park in 2006 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 [13].(Figure 11)

12. Atraumatic Transpalatal arch
Valentin Moutaftchie, Alexander Moutaftchiev 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 [14].(Figure 12).

13.Fibre reinforced composite TPA
Pizzoni in 2010 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 [15].(Figure 13)

14. M-TPA with customized bonding base
M. Fujisawa & A. Komori in 2011 modified TPA (M-TPA) by customizing bonding base, whichcan be directly bonded using resin-reinforced glass ionomer cement. M-TPA provides a tight fit as it contacts large area. M-TPAcan be removed as per anchorage requirements without disturbing labial fixed appliances as it is bonded on lingual side [16].(Figure 14)

15.Individually prepared TPA
Vijay Reddy, Mrajesh Reddy, MrenuParmar in 2012 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 [17].(Figure 15)

16. TPA for scissor bite correction
Sujala D, K Nagaraj in 2012 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 [18]. (Figure 16)

17. TPA for molar intrusion
Lee et al in 2013 fabricated miniscrew supported TPA to reinforceanteroposterior and vertical anchorageof 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 [19].(Figure 17)

18. TPA proclination spring
Paduano S, Spagnuolo G, BiaseGd, Cioffi I.in 2013 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 [20].(Figure 18)

19.Tongue friendly TPA
Gupta A, Kannan S., Gupta G., Goyaliya A. Kaul A., Garg N. in 2013 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 [21].(Figure 19)

20.Butterfly Arch
AlirezaNikkerdar in 2013 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 [22].(Figure 20)

21.TPA for molar intrusion
Kumar ND et al 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 [23]. (Figure 21)

22.TPA for bucally placed 2nd maxillary molar
Mehta F, Patel R, Kharadi L, Mehta S modified TPA in 2014 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 [24].(Figure 22)

23.TPA for bilateral molar intrusion
Hassan S, Shah MJ in 2014 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 [25].(Figure 23)

24. Asymmetric TPA for molar intrusion
Riddhi, Prasad S in 2015 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 [26].(Figure 24).

25.TMA-TPA
Tsetsilas M et al in 2015fabricated TPA using titanium molybdenum alloy (TMA) and fitted with 0.032" x 0.032" Burstone lingual brackets for symmetric and asymmetric expansion of molars [27].(Figure 25).

26.Mini-implant aided TPA
Miresmaeilia A et al in 2015 usedmini-implant-aided TPAwith 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 [28].(Figure 26).

27. M shaped palatal arch 2017
Kapadia RM in 2017 introduced M-shaped palatal arch which has three loops; one center loop and two compensatory loops for bilateral molar scissor bite correction [29].(Figure 27).

28.Transpalatal arch for expansion 2017
Thomas A et al in 2017 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 [30].(Figure 28).

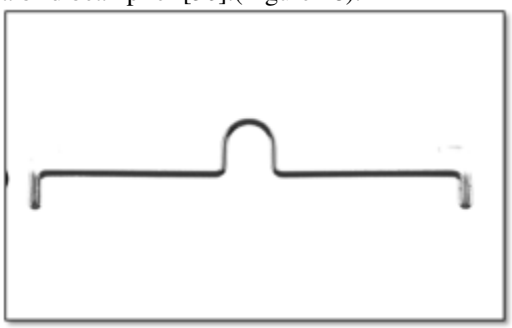

Figure 1: Goshgarian Appliance/Transpalatal arch.

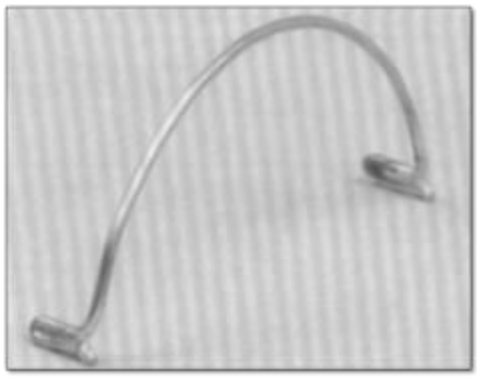

Figure 2: Transpalatal lingual arch.

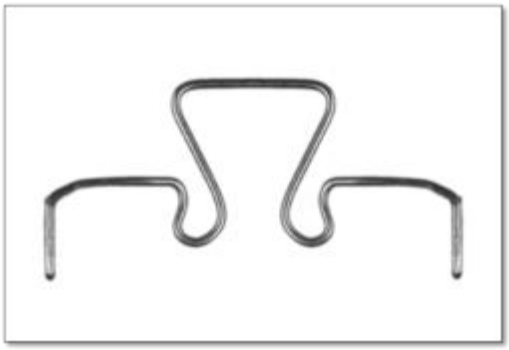

Figure 3 : Occlusal view of a Zachrisson-type transpalatal bar.

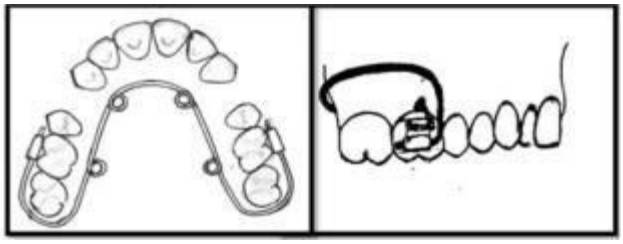

Figure 4 : Wallis and Vasir modified quad helix/ transpalatal arch attachment occlusal view and side view 1998

Figure 5: Goshgarian arch combined with Nance button 1998

Figure 6: Hudson Tongue Friendly TPA – 2000

Figure 7 : TMA – TPA Asymmetric Distalization – 2001

Figure 8 : TPA with Bilateral Helix – 2002

Figure 9: Keles TPA 2003

Figure 10 : Bonded Transpalatal Arch 2004

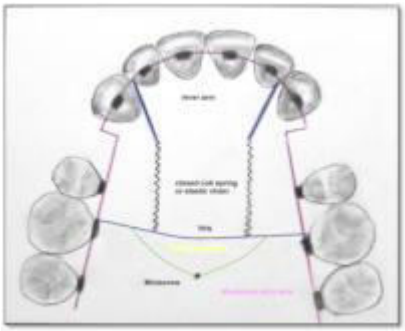

Figure 11: Miniscrew assisted TPA – 2006

Figure 12: Individually prepared Transpalatal arch – 2009

Figure 13: Fibre Reinforced Composite Transpalatal arch – 2010

Figure 14: Modified TPA with customized bonding base – 2011

Figure 15: Modified Transpalatal Arch for Correction of Scissor Bite - 2012

Figure 16: Modified Transpalatal Arch for Molar Intrusion - 2012

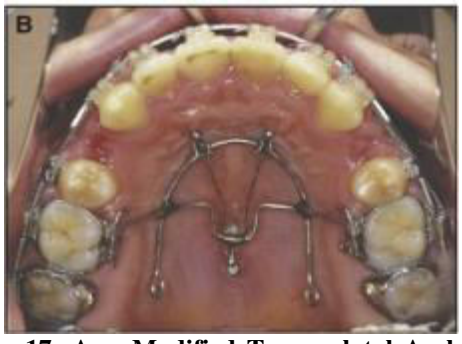

Figure 17: A, a Modified Transpalatal Arch with distally extending arms to control the posterior teeth (a, 1 stabilization hook; b, 2 anchorage hooks); - 2012

Figure 18: Modified Transpalatal Arch Proclination spring - 2013

Figure 19 : Modified Transpalatal Arch with archwire sleeve - 2013

Figure 20 : Butterfly Arch - 2013

Figure 21 : Modified Transpalatal arch for intrusion - 2013

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

Figure 23 : Modified Transpalatal arch for bilateral molar intrusion - 2014

Figure 24 : Asymmetrical Transpalatal arch - 2015

Figure 25: TMA Transpalatal arch fitted in Burstone lingual brackets - 2015

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

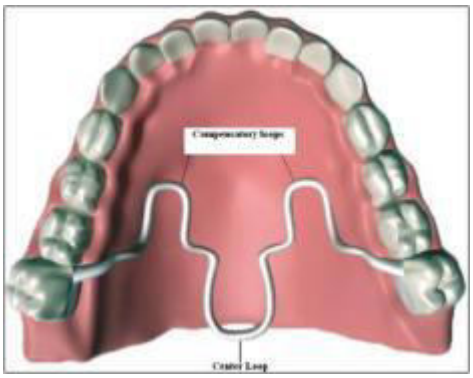

Figure 27 : M shaped palatal arch 2017

Figure 28: Transpalatal arch for expansion – 2017

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 [31].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 [32]. (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 [2].

In a comparison study between mini-screw implant and transpalatal arch by Liu YH, Liu J it was found that mini

screw implant could not only retract the upper incisors but also slightly intrude upper incisors and upper molars [33]. 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 [34].

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.

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