A randomized clinical trial to compare the Goshgarian and Nance palatal arch

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SUMMARY The aim of this trial was to evaluate whether a Nance or Goshgarian palatal arch was most effective for prevention of mesial drift, distal tipping, prevention of mesio-palatal rotation of the upper first permanent molars, and patient comfort and ease of removal. Patients were recruited from a district general hospital and a specialist orthodontic practice and randomly allocated to a Goshgarian (n = 29) or a Nance (n = 28) group. Pre-treatment study models (T1) were taken followed by the placement of the palatal arch, premolar extractions, and upper and lower fixed appliances. The clinical end point was 6 months (T2), at which time, an impression for an upper study model was taken. The amount of upper first permanent molar mesial movement, distal tipping, and mesio-palatal rotation was measured by scanning T1 and T2 study models and then using a software program to calculate molar changes. In addition, the patients recorded their discomfort scores using a seven-point Likert scale at each recall visit.

Forty-nine patients (86 per cent) completed the trial. *t*-tests were used to compare molar movements between the Goshgarian and Nance palatal arch groups. There were no statistically significant differences between the palatal arches in terms of prevention of mesial drift or distal tipping (P > 0.05). There was a statistically significant difference in the amount of molar rotation between the arch types, with both exhibiting some disto-palatal rotation even though they were not activated for this movement. The Goshgarian palatal arch produced marginally more disto-palatal rotation than the Nance arch (P = 0.02), although this may not be considered clinically significant. A Mann–Whitney test revealed that there was also a statistically significant difference in pain scores between the Goshgarian and the Nance arch, with the latter being associated with more discomfort (P = 0.001). This trial did not support any preference in the use of the Goshgarian or Nance palatal arch, unless the slightly reduced patient discomfort with the Goshgarian arch is considered significant.

Introduction

Transpalatal arches are routinely used in orthodontic treatment in both the permanent and mixed dentition. Their mode of action can be divided into passive, to stabilize or reinforce anchorage, or active, to enable tooth movement. Thus, tooth movement may be undertaken for a single tooth or blocks of teeth in the horizontal, sagittal, and vertical directions. A number of active tooth movements are possible with a palatal arch, including derotation of unilateral or bilateral rotated molars (Cooke and Wreakes, 1978; Ten Hoeve, 1985; Dahlquist et al., 1996; Ingervall et al., 1996). Transpalatal arches may also be used to correct molar crossbites, which is well described in a prospective clinical study by Ingervall et al. (1995). Further reports in the literature describe the use of palatal arches as a mode for asymmetric or symmetric distalization (Ten Hoeve, 1985; Mandurino and Balducci, 2001) and buccal or lingual root torque of the upper molars (Baldini and Luder, 1982).

More commonly, palatal arches are used to reinforce anchorage and prevent mesial movement of the upper first permanent molars during treatment. The anchorage value is increased by maintaining a fixed intermolar width across the arch, so that as the molars loose anchorage by drifting forwards, their roots engage the buccal cortex, which theoretically will prevent further forward drift. However, this concept of cortical anchorage is not supported scientifically; joining the molar teeth together, thus doubling their root surface area and therefore increasing their resistance to unwanted mesial drift; or controlling molar rotation and tipping and thus, to some extent, restricting forward movement of the upper first permanent molars.

The Nance (Nance, 1947) and Goshgarian (Goshgarian, 1972) palatal arches (Figure 1) have been described in the literature as providing reinforcement of anchorage, but no comparison of the effectiveness of two types of palatal arch have been scientifically evaluated.

Therefore, the aim of the study was to evaluate whether a Nance or a Goshgarian palatal arch was the most effective for prevention of mesial drift, distal tipping, prevention of mesio-palatal rotation of the upper first permanent molars, and patient comfort and ease of removal.

Subjects and method

Approval for the study was obtained from North Manchester (03/NM/626) and Cheshire (M248/03) Local Regional Ethics Committees.





Figure 1 The Nance (a) and Goshgarian (b) palatal arches.

Sample size calculation

Since there was no comparative literature to suggest an expected difference between the Nance and Goshgarian palatal arches for loss of anchorage, a clinically significant difference of 2 mm of mesial movement between groups was used. A sample size in each group of n = 23, with a 0.050 two-sided significance level, will have a 90 per cent power to detect a difference of 2 mm of mesial movement of the upper first permanent molars between the Nance and the Goshgarian palatal arch groups, assuming a common standard deviation of 2 mm. Thus, a total of 46 patients needed to be recruited.

The sample was obtained by approaching consecutive patients, who fulfilled the inclusion criteria, attending for fixed orthodontic treatment at Tameside General Hospital, Ashton-under-Lyne, Lancashire, UK and a specialist orthodontic practice in Crewe, Cheshire, UK. The treatment was conducted by one orthodontic consultant (NAM), one specialist practitioner in orthodontics (CL), and one orthodontic postgraduate (NS).

Inclusion criteria

- 1. Patients aged 10-17 years at the start of treatment.
- 2. Upper premolar extractions.
- 3. Patient just about to commence orthodontic treatment.
- 4. Upper and/or lower preadjusted edgewise appliance (McLaughlin, Bennett, Trevisi/MBT prescription) and stainless steel brackets.
- 5. Patient and parent informed and written consent.

Exclusion criteria

- 1. Requiring upper first permanent molar extractions.
- 2. Correction of a crossbite with expansion of the upper arch.
- 3. Non-extraction upper arch treatment.
- 4. Cases that required extra oral anchorage reinforcement or distal movement of the upper first permanent molars.
- 5. Patients requiring orthognathic surgery.
- 6. Lack of consent.

Randomization was carried out using random number tables, where even numbers were assigned to the Nance palatal arch group and odd numbers to the Goshgarian palatal arch group. A restricted randomization method was used in blocks of 10 to ensure that equal numbers of patients were allocated to each treatment group. The treatment allocation was concealed in an opaque envelope and labelled with the study identification number. When the patient consented to the trial, the envelope was opened to reveal the treatment allocation. During the trial, the operator could not be blind to treatment allocation; however, the examiner who measured the study models (NS) did not know whether a Nance or a Goshgarian palatal arch had been used.

The type of malocclusion was recorded using the Incisor Classification of the British Standards Institution (1983). A standardized procedure was then used for every patient and the palatal arches fitted immediately prior to the upper arch extractions and fixed appliance placement. Both palatal arches were constructed using 0.9 mm stainless steel and were soldered to the molar bands. In the case of the Goshgarian palatal arch, the loop faced distally and was constructed so that it was 2-3 mm away from the palatal mucosa. The Nance palatal arch was designed with a large acrylic button extended to cover the steepest and deepest depth of the anterior palatal vault. Both palatal arches were cemented with chemical cure glass ionomer cement (Intact; Orthocare, Bradford, West Yorkshire, UK). The aim was not to activate the palatal arch to derotate the molars since the effectiveness of the prevention of mesiopalatal rotation was being investigated. In two subjects (one in each group) where the upper first molars were considerably mesio-palatally rotated at the start of treatment, a derotation activation was placed bilaterally in the palatal arch and these patients were excluded from the analysis.

The remaining fixed appliance was then fitted using MBT prescription with an archwire sequence of 0.016 inch nickel titanium (Ni-Ti), 0.018 \times 0.025 inch Ni-Ti and 0.019 \times 0.025 inch stainless steel. During the levelling and aligning phase of treatment, which comprised a 6 month observation period, no mechanics were used that may have brought the upper first permanent molars more mesially than would be assumed by loss of anchorage alone. In addition, no canine lacebacks were placed. The palatal arch was removed at the clinical end point of 6 months (T2). The patients were then sent away for 1 week and told to brush their palate. This was to ensure that the palatal mucosa in the Nance palatal arch group was not swollen or hyperplastic when the impression was taken, as this would have enabled the observer to determine that the patient had worn the Nance palatal arch. One week after removal of the palatal arch, an end point upper alginate impression was taken and either new upper first molar bands were cemented or the palatal arch was re-cemented if it was deemed clinically necessary.

Outcome measures

The following outcome measures were assessed in relation to the position of the upper first permanent molars: mesial movement, distal tipping, prevention of mesio-palatal rotation, patient discomfort, ease of removal of the palatal arch, and whether or not local anaesthesia was required for removal.

Mesial movement, distal tipping, and prevention of mesiopalatal rotation were assessed by comparing the difference in the position of the upper first permanent molars on the T1 and T2 study models. The models were scanned with an updated version of the Konica Minolta Vivid 700 three-dimensional (3D) laser scanner (www.konicaminolta.com). The laser digitizer is placed on a moveable turntable and a point of laser light is shone on the surface of the object to be scanned. The reflected beam is then intercepted by a sensor, which converts it into 3D co-ordinates; this is known as triangulation. The computer software program, Rapid Form 2004 (Konica), was then used to create the 3D model and calculate the tooth movements of interest using the palatal rugae as reference points. Figure 2 shows the measurements taken on one set of start (T1) study models.

Patient discomfort was measured on a seven-point Likert scale, at each visit, where a score of 1 indicated no pain and a score of 7 severe pain. A mean score was calculated. Ease of removal of each palatal arch was recorded as whether the palatal arch embedded or impinged on the palatal mucosa (yes/no) and whether local anaesthesia was required for its removal (yes/no).

Method error

Systematic error was reduced by the examiner being blind to the treatment group when the model measurements were carried out. The examiner was also blind as to whether the models were obtained at T1 or T2. All models were measured in a random order so the patients' T1 and T2 models were not measured consecutively. Random error was reduced by measuring all study models twice and calculating a mean.

Examiner calibration and reliability

The examiner was trained in the use of the laser scanner and calibration was carried out using four plaster calibration cubes with different known heights and widths that had been verified by the Engineering Department, University of Manchester, UK as the gold standard. Intra-examiner reliability of the measurements was assessed by re-measuring 20 study models after an interval of at least 1 week.

Statistical analysis

The data were checked for normality and simple summary statistics produced. t-tests were used to compare the palatal arch groups in terms of upper first permanent molar mesial movement, distal tipping, and prevention of mesio-palatal rotation. Left and right molar movements were averaged for analysis. A Mann-Whitney test was used to compare pain scores between the two palatal arch groups and chisquare statistics to compare the groups in terms of ease of removal of the palatal arch and whether or not local anaesthesia was required. Examiner calibration and reliability was assessed using intraclass correlation coefficients (ICC). Pearson correlation coefficients for examiner calibration were 1.00 for height measurements and 0.99 for width measurements. Intra-examiner reliability for all tooth movement measurements was high, with an ICC of 0.98 or above.

Results

The trial profile is shown in Table 1. Of the 57 patients initially registered, the final sample size for data analysis was 49. Six patients (four females and two males) were not included in the data analysis since they were lost to follow-up. Two further patients needed disto-palatal activation of their palatal arches so were excluded from the analysis. The mean age for the Goshgarian palatal arch group was 14 years 6 months and that of the Nance group 14 years 3 months. There was no statistically significant difference between the groups for age (P = 0.54), thus exhibiting pre-treatment equivalence for this variable. In addition, there was no statistically significant difference in gender between the two palatal arch groups (P = 0.035) or initial malocclusion (P = 0.29).

Upper first permanent molar mesial movement, distal tipping, and prevention of mesio-palatal rotation

Table 2 shows that there was no statistically significant difference between the Goshgarian and Nance palatal arch in



terms of prevention of mesial movement or distal tipping (P > 0.05). The average mesial movement for both groups was in the order of 0.5–1 mm over the 6 month period. Overall, there was, in fact, mesial tipping for both groups and this was in the order of 2–3 degrees, with wide standard deviations.

: 101.71484 deg

Figure 2 Upper first permanent molar mesial movement (a and b), tipping (c), and rotation (e and d).

0.97976, 0.04106, 0.19593

. 1

In contrast, there was a statistically significant difference in the prevention of mesio-palatal rotation between the palatal arch groups. The Goshgarian palatal arch group exhibited a small amount of disto-palatal rotation of around 4.5 degrees compared with the Nance at just over 2 degrees (P = 0.017). This was surprising as the palatal arches were not activated for disto-palatal rotation but there was still a tendency for this movement to occur between 2–4 degrees in both groups.

Patient discomfort scores and ease of removal of the palatal arches

There was a statistically significant difference in discomfort scores between the two groups, with the Nance palatal arch reported to be more uncomfortable (median Likert score = 2) compared with the Goshgarian (median Likert score = 1; P = 0.001). No gagging problems were reported with either palatal arch design. Two Nance palatal arches, but no Goshgarian palatal arches, were embedded in the mucosa (chisquare 2.002, 1 degree of freedom, P value = 0.16). No local anaesthesia was required to remove any of the palatal arches.

Assessment of potential bias through patients who dropped out of the study was carried out by comparing the malocclusion, gender, and age between the patients staying in and those dropping out of the study. There was no statistically significant difference between the patients remaining in the study and those who did not (P > 0.05), so there should be no bias as a result of losing eight patients from the sample.

Discussion

This trial did not find a clinically significant difference between the Nance and Goshgarian palatal arches in terms

Table 1 Trial profile.

Registered patients $n = 57$						
Not randomized $n = 0$	Randomization $n = 57$					
Goshgarian palatal arch Intervention $n = 29$ Followed-up $n = 24$ Withdrawn $n = 1^*$ Intervention ineffective $n = 0$ Lost to follow-up $n = 4$ Completed trial $n = 24$	Nance palatal arch Intervention $n = 28$ Followed-up $n = 25$ Withdrawn $n = 1*$ Intervention ineffective $n = 0$ Lost to follow-up $n = 2$ Completed trial $n = 25$					

*Withdrawn from analysis because palatal arch activated for derotation.

of prevention of mesial drift, distal tipping, or prevention of mesio-palatal rotation of the upper first permanent molars. However, there was a difference between the two groups in terms of increased discomfort experienced by the patients wearing the Nance palatal arch.

The results of this study revealed that the amount and type of tooth movement from the two appliances was small. When the average molar movement between the right and left sides was measured for each palatal arch type, the Goshgarian palatal arch allowed the molars to mesialize slightly more than the Nance (0.94 versus 0.72 mm) over a 6 month period. These values were very small and indeed there was no statistically or clinically significant difference between the arch types in preventing anchorage loss. It is difficult to make comparison with previous literature because of the lack of randomized clinical trials. Although not directly related to the appliances used in this trial, Rebellato et al. (1997) conducted a prospective clinical trial investigating whether a lower lingual arch was effective at preventing mesial migration of the lower first permanent molars. Their results showed that the molars mesialized in the treatment group by 0.29 mm, which was marginally less than the findings in the present study. However, caution must be exercised when making comparisons between studies: firstly the investigation by Rebellato et al. (1997) had no fixed appliance in situ and secondly they were investigating mandibular molar movement, which tends to be slower than its maxillary counterpart.

This trial demonstrated that in some patients the molars rotated mesio-palatally during treatment but the overall average was for the molar to derotate disto-palatally (4.4 degrees with the Goshgarian and 2.1 degrees with the Nance). The difference was statistically significant; however, it is doubtful whether a difference of only 2.3 degrees between groups is clinically significant. In addition, it is difficult to explain why any disto-palatal rotation occurred in either group, as the palatal arches were not activated to straighten the molars. It is possible that the 0.019 × 0.025 inch stainless steel working archwire, in conjunction with the appliance prescription, caused a mean disto-palatal molar rotation, despite a rigid soldered palatal arche being in place.

Table 2 Comparison of Nance and Goshgarian palatal arches for upper first permanent molar mesial movement, tipping, and rotation.

Tooth movement	Palatal arch	Mean (SD)	SE mean	t value	P value	95% Confidence interval
Mesial movement (mm)	Goshgarian	0.98 (1.02)	0.20	0.68	0.50	-0.44 to 0.90
	Nance	0.72 (1.33)	0.26			
Rotation * (°)	Goshgarian	4.43 (3.74)	0.75	2.50	0.02	0.44 to 4.19
	Nance	2.11 (2.68)	0.55			
Tipping * (°)	Goshgarian	-2.09(4.29)	1.07	0.37	0.72	-3.07 to 4.41
	Nance	-2.75 (6.04)	1.46			

*+ve value indicates disto-palatal rotation or distal tipping; -ve value indicates mesio-palatal rotation or mesial tipping.

Although the findings demonstrated that in some patients the molars tipped distally, this was in a minority of cases and the overall tendency was for the molars to tip mesially (2.09 degrees with the Goshgarian and 2.75 degrees with the Nance). The difference between the groups was not statistically significant and thus one appliance was no better than the other for preventing mesial tipping. It was perhaps surprising that more distal tipping was not observed in the Goshgarian group as Chiba *et al.* (2003) suggested that tongue pressure on a distally directed U loop would tip the molars distally. It is probable that the design in this study to minimize patient discomfort, meant that the position of the U loop was too near the palate for tongue pressure to have had a significant tipping effect.

The clinical end point of 6 months was used to avoid any delay in treatment since some patients were ready for space closure mechanics. It would have been clinically useful to continue measuring anchorage loss during space closure. However, this was not carried out because some patients required no further anchorage reinforcement and the palatal arch needed to be removed to allow mesial movement of the upper buccal segments.

When the possibility of the palatal arch embedding in the oral mucosa was considered, again there were no statistically significant differences between the palatal arch types. This is not in agreement with the general clinical observation that Nance palatal arches tend to embed into the palatal mucosa because of the proximity of the palatal acrylic to the palate. However, the two arches that did embed were of the Nance design but local anaesthesia was not needed for their removal. It may be that the absence of acrylic embedding into the palatal mucosa was because the surface area of the acrylic was large, or that no significant space closure mechanics were used during the 6 month observation period.

Clinical significance

Generally, no differences were observed between the clinical behaviour of the Goshgarian and Nance palatal arches. Although some statistically significant differences were found between the groups, examination of the mean values did not suggest a clinically meaningful difference. Thus, when a clinician is choosing which palatal arch to use, both designs are effective in only allowing around 1 mm of mesial movement of the upper first permanent molars over a 6 month period.

Consideration was given to whether to include a group with no palatal arch. However, there was a possibility that a group with low anchorage requirement, and no need for a palatal arch, may have been inherently different compared with patients requiring one. Therefore, a group with no palatal arch could have had different start characteristics and not be comparable with the other groups at baseline. For this reason, it was decided to compare two types of palatal arch and not attempt to introduce a control group.

Conclusions

There was no statistical or clinical advantage in the use of either the Goshgarian or Nance palatal arch in terms of prevention of mesial molar movement or distal molar tipping during the first 6 months of orthodontic treatment. Differences in prevention of mesio-palatal rotation are unlikely to be clinically significant. The trial does not support the use of one palatal arch or another, unless the slightly reduced patient discomfort for the Goshgarian arch is considered clinically significant.

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References

- Baldini G, Luder H 1982 Influence of arch shape on the transverse effects of transpalatal arches of the Goshgarian type during application of buccal root torque. American Journal of Orthodontics 81: 202–208
- British Standards Institution 1983 British Standard Incisor Classification. Glossary of dental terms BS4492. British Standard Institute, London
- Chiba Y, Motoyoshi M, Namura S 2003 Tongue pressure on loop transpalatal arch during deglutition. American Journal of Orthodontics and Dentofacial Orthopedics 123: 29–34
- Cooke M S, Wreakes G 1978 Molar derotation with a modified palatal arch: an improved technique. British Journal of Orthodontics 5: 201–203
- Dahlquist A, Gebauer U, Ingervall B 1996 The effect of a transpalatal arch for the correction of first molar rotation. European Journal of Orthodontics 18: 257–267
- Goshgarian R A 1972 Orthodontic palatal arch wires. United States Government Patent Office. Alexandria, Virginia (Patent number 3792529)
- Ingervall B, Göllner P, Gebauer U, Fröhlich K 1995 A clinical investigation of the correction of unilateral first molar crossbite with a transpalatal arch. American Journal of Orthodontics and Dentofacial Orthopedics 107: 418–425
- Ingervall B, Hönigl K D, Bantleon H P 1996 Moments and forces delivered by transpalatal arches for symmetrical first molar rotation. European Journal of Orthodontics 18: 131–139
- Mandurino M, Balducci L 2001 Asymmetric distalisation with a TMA transpalatal arch. Journal of Clinical Orthodontics 35: 174–178
- Nance H N 1947 The limitations of orthodontic treatment 1: mixed dentition diagnosis and treatment. American Journal of Orthodontics and Oral Surgery 33: 177–223
- Rebellato J, Lindauer S J, Rubenstein L K, Isaacson R J, Davidovitch M, Vroom K 1997 Lower arch perimeter preservation using the lingual arch. American Journal of Orthodontics and Dentofacial Orthopedics 112: 208–217
- Ten Hoeve A 1985 Palatal bar and lip bumper in non-extraction treatment. Journal of Clinical Orthodontics 4: 272–291

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