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The Effectiveness and Efficiency of Hygienists in Carrying Out Orthodontic Auxiliary Procedures

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Abstract *The aim of this study was to compare the ability and efficiency of dental hygienists, after preliminary training as orthodontic auxiliaries, with post-graduate orthodontists. The study was cross-sectional and prospective. The sample consisted of five second-year hygienists and five qualified orthodontists from Manchester University Dental Hospital. All subjects carried out a range of orthodontic exercises on phantom head typodonts. The ability and efficiency for each task was measured, and comparison made between hygienist and orthodontic groups.*

There was no statistically significant differences between hygienists and orthodontists in terms of their ability to carry out potential orthodontic auxiliary procedures. However, orthodontists were more efficient ($P < 0.05$*).*

The ability of hygienists to carry out potential orthodontic auxiliary tasks after appropriate training is supported. Trained orthodontists are more efficient than newly trained hygienists in carrying out potential orthodontic auxiliary tasks.

Index words: Orthodontic Auxiliaries; Dental Hygienists; Ability; Efficiency.

Introduction

Recently, some dental hospitals in the U.K. have piloted orthodontic auxiliary training courses (Turner and Pinson, 1993; Stephens, 1996). It may be argued that such steps are long overdue because the U.S.A. and many European countries already use orthodontic ancillary staff (Gottlieb *et al*., 1987; Moss, 1993). Furthermore, the use of such staff in this country was suggested over 10 years ago (Shaw, 1983).

In 1988, a proposal was made to introduce orthodontic auxiliaries into the U.K. (O'Brien and Shaw, 1988), with delegation of routine tasks such as separation, band and bond placement, ligation, and removal of archwires and impression taking. Shortly after, the Nuffield Inquiry was set up to examine whether and how far the role of auxiliaries could be expanded. The subsequent report (Nuffield Inquiry, 1993), recommended the development of training courses, a nationally approved certificate of training and development of orthodontic auxiliaries.

These recommendations were supported by the British Orthodontic Society (BOS) (1992). However, the BOS additionally stipulated that a suitably qualified orthodontist should supervise work. Furthermore, it would be important to determine the most efficient method of delivering high quality care and effective skill mix ratios for orthodontic practice. Further issues were highlighted by Stephens (1996) concerning details of training, and implications for patient access to care and NHS costing.

Perhaps the most pressing question at this stage is the competence and cost-effectiveness of potential orthodontic auxiliaries. Generally, dental ancillary staff have been shown to carry out simple restorative procedures and remove composite, following debond, to a similar level of competence to dentists (Hammons *et al*., 1971; Oliver and Griffiths, 1992). In addition, dental hygienists and therapists reliably diagnosed caries in an epidemiological survey when compared with dentists (Kwan *et al*., 1996). However, orthodontic tasks have not been assessed in this way.

It is important to consider not only the quality of the delegated procedure, but also the cost-effectiveness of ancillary personnel. In a simulated general practice situation at the University of Alabama, Overstreet *et al*. (1978) showed that addition of one unassisted auxiliary to a dental team increased patient load by 48·8 per cent and revenue by 50 per cent per day. However, the addition of a second auxiliary only increased the patient load by a further 9·7 per cent, and giving the auxiliary an assistant produced no productivity or revenue gain. It was thought that increasing the number of auxiliaries significantly would slow the dentist down and their work speed was the most important factor with respect to patient throughput.

Aim

The aims of this study were, first, to assess the ability of hygienists to carry out certain orthodontic procedures. Secondly, to make a preliminary investigation into the efficiency of newly trained orthodontic auxiliaries.

Materials and Methods

Sample

The hygienist sample consisted of all second year trainees at Manchester University Dental Hospital ($n = 5$). These hygienists had just completed a pilot course of proposed

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orthodontic auxiliary procedures. As a comparison group, five orthodontists were selected who had completed their 3-year specialist training. This comprised three registrars and two senior registrars.

Hygienist Training

A pilot orthodontic auxiliary training course was carried out at Manchester University Dental Hospital from October 1996 to April 1997. Five hygienists, entering their second year, completed a modular programme 1 day a week for two terms. This consisted of lectures and demonstrations followed by practical exercises on typodonts.

The Typodonts

The typodonts (Sankin Kogyo, Japan) consist of teeth (Rocky Mountain Morita Corporation) set up in wax in the form of a Class II division 1 malocclusion. The crowns and roots are made of metal, and the crown is covered with composite to simulate enamel. Pre-adjusted edgewise bands and brackets (022 slot) were bonded onto the arches by the two tutors (NM and MR). The typodonts were then attached to dental chairs via a customized metal attachment. Thus, the operators could work under conditions that resembled a patient position.

The typodonts were labelled 1–4. Each person successively moved from typodont 1–4 and completed the designated exercises for each (Table 1). When the person moved to the next typodont, the exercises that they had just completed were assessed. Following this, the typodont was returned to the original state for the next candidate.

Table 1 also shows the sliding scale of marks for each procedure ranging from zero to the maximum score possible for that particular exercise. A procedure was deemed to be carried out to an unacceptable standard if two or more marks were lost for any procedure except banding. For the banding exercise, the standard was thought unacceptable if four or more marks were lost for the two band placements.

Measure of Ability

Each exercise was assessed according to specific criteria. A mark was given for each criterion successfully carried out and a total score given for each task. The gold standard against which hygienist ability was measured was the average score of the five trained orthodontists who were assessed in the same way. The procedures assessed and criteria used are summarized in Table 1.

Measure of Efficiency

The time taken for each procedure in Table 1 was recorded to the nearest minute. The gold standard was the time taken for trained orthodontists to carry out the same procedures.

Intra-examiner Reliability

The reliability of the examiner (NM) was assessed for the procedures in Table 1 by recording scores on typodonts set up purely for that purpose. The same typodonts were re-assessed 3 weeks later.

Statistical Analysis

The median, mean, and standard deviation were calculated for each exercise score, and the time taken by hygienists and orthodontists. The orthodontist and hygienist groups were then compared using the Mann–Whitney test for non-parametric data at the $P < 0{\cdot}05$ level. Weighted kappa was used to assess intra-examiner reliability. Lastly, since the sample size was small and restricted by the number of hygienists in their second year, a power calculation was carried out that is addressed in the discussion.

TABLE 1 *Criteria used to assess hygienist ability to carry out potential orthodontic auxiliary tasks*

Procedure	Measurement criteria	Range of possible scores
Elastic separators (4)	Palced at mesial and distal contact points, placed around the contact points	0–8
Molar bands (2)	Correct orientation, band tubes parallel to occlusal plane, margin just below mesial marginal ridge, margin just below distal marginal ridge, correct band size, correct height of slot	0–12
Figure of 8 tie around upper incisors	Long tie runs 2–2, correctly placed around bracket wings, sufficient tension, free end tucked in atraumatically	0–4
Canine lacebacks (2)	Run from 3–6, sufficient wire tension, free end tucked in, placed under archwire	0–8
Archwire placement with elastic modules (2)	Archwire cut to correct length, tied into brackets sufficiently, modules correctly placed around wings	0–6
Rotation wedge	Placed correctly on wings, appropriate side for derotation, archwire groove upwards, placed under archwire, archwire tied on other side of bracket	0–5
Power chain upper 2–2	Placed on correct teeth, correctly around bracket wings, suitable tension (stretched to ×2 resting length)	0–3
Archwire placement with quickties (2)	Archwire cut to correct length, archwire tied into brackets sufficiently, correctly placed around bracket wings, free ends tucked in atraumatically	0–8
Kobayashi hook (2)	Placed over archwire, hook orientated in correct direction, free end tucked atraumatically	0–6
Bergman ligatures (2)	Tied mesial to upper canine, runs 3–6, elastic stretched to ×2 length, free end tucked in, wire twisted for part of length	0–10
Power chain from 3–6 hooks (2)	Stretched from 3–6 hook, stretched to ×2 original length)	0–4

Results

No statistically significant differences were found in the ability of the hygienists and orthodontists to carry out potential orthodontic auxiliary procedures. The mean and median scores for each exercise and probability (*P*) values are shown in Table 2. When the efficiency, (time taken in minutes) of the two groups was compared, the orthodontists were between approximately two and four times more efficient than the hygienists. This varied according to the type of procedure (Table 3). The group difference was statistically significant for all procedures ($P < 0.05$) except (i) placement of two canine lacebacks, and (ii) placement of power chain on the four upper incisors.

Weighted kappa for the intra-examiner reliability was 0·995 (95 per cent confidence intervals 0·987–1·000).

Discussion

Ability of Potential Orthodontic Auxiliaries

This study has suggested that certain orthodontic tasks can be carried out by hygienists to a similar level to orthodontists. This is indirectly supported by previous findings of the competence of general dental auxiliaries compared with dentists (Hammons *et al*., 1971; Oliver and Griffiths, 1992; Kwan *et al*., 1996). However, comparison with previous publications is made with care for two reasons; (i) orthodontic tasks are different to general dental procedures, and (ii) this was an *in vitro* study and is not necessarily indicative of the patient situation.

Subjectively, procedures such as band placement appeared to be carried out much quicker on the typodonts compared with clinical experience of band placement and clinical expertise on patients needs investigation. Consideration should also be given to the relatively small sample size in this and previous studies. It may be that the study lacked power to detect a difference between the ability of the two operator groups. To investigate this, a power calculation was carried out. With a sample size of five per group, if the scores for orthodontists are mutually exclusive of the hygienist group, a statistically significant difference between groups could be detected with a power of 80 per cent ($P < 0.05$). For example, if the orthodontists all scored 7 or 8 out of 8 marks, and the hygienists scored 4 or 5 out of 8 marks, their marks would be mutually exclusive. In any event, the actual marks achieved by the hygienists were as good as the orthodontists and there is no reason to suggest that their ability would be below that of the orthodontists.

Efficiency of Potential Orthodontic Auxiliaries

Orthodontists were found to be approximately 2–4 times more efficient than a newly trained orthodontic auxiliary and this may have clinical implications. An interpretation of this could be that a ratio of orthodontist:auxiliary of 1:4 would be required to maintain productivity and income assuming the orthodontist is purely supervising. It might be predicted that if the orthodontist is treating patients and working with one auxiliary, then an increase in patient throughput of 25 per cent may be reached and this may well increase as the auxiliary speeds up. Arguably, an orthodontist and two auxiliaries should increase productivity by 50 per cent. However, the data of Overstreet *et al*. (1978) may guard against this assumption, since it seems that the speed of the orthodontist (which will be affected by the numbers needing supervision) may be the key factor in overall productivity.

Of course, the hygienists had only had a limited training, while the orthodontists had daily activity, and this is likely to reflect in differences in efficiency at this stage. With increased experience, hygienists may well work at similar rates to more experienced clinicians.

TABLE 2 *Mann–Whitney test to compare the ability of hygienists and orthodontists to carry out potential orthodontic auxiliary tasks*

Test variable	Group (SD)	Mean score score	Median (corrected for ties)	*P* value
Elastic separators	Hygienist	8·0 (0·0)	8·0	0·32
	Orthodontist	7·8 (0·5)	8·0	
Molar bands	Hygienist	9·0 (2·1)	9·0	0·29
	Orthodontist	10·4 (1·8)	11·0	
Figure 8 tie	Hygienist	3·6 (0·6)	4·0	0·13
	Orthodontist	4·0 (0·0)	4·0	
Canine lacebacks	Hygienist	7·6 (0·9)	8·0	1·0
	Orthodontist	7·6 (0·9)	8·0	
Archwires with elastic modules	Hygienist	5·4 (0·6)	5·0	0·22
	Orthodontist	5·8 (0·5)	6·0	
Rotation wedge	Hygienist	4·8 (0·5)	5·0	0·32
	Orthodontist	5·0 (0·0)	5·0	
Powerchain upper 2–2	Hygienist	2·8 (0·5)	3·0	0·32
	Orthodontist	3·0 (0·0)	3·0	
Archwires with quickties	Hygienist	6·6 (0·9)	6·0	0·37
	Orthodontist	7·0 (0·7)	7·0	
Kobayashi hook	Hygienist	5·8 (0·5)	6·0	0·32
	Orthodontist	6·0 (0·0)	6·0	
Berman ligatures	Hygienist	8·6 (2·6)	10·0	0·14
	Orthodontist	10·0 (0·0)	10·0	
Power chain 3–6	Hygienist	3·6 (0·9)	4·0	0·51
	Orthodontist	3·2 (1·1)	4·0	

TABLE 3 *Comparison of the efficiency of hygienists and orthodontists to carry out potential orthodontic auxiliary tasks in terms of the time taken (minutes) to carry out each task*

Test variable	Group	Mean score in minutes (SD)	Median score in minutes	*P* value (corrected for ties)
Elastic separators	Hygienist	4·2 (2·1)	5·0	0·005
	Orthodontist	1·0 (0·0)	1·0	
Molar bands	Hygienist	7·4 (4·0)	6·0	0·027
	Orthodontist	3·2 (1·3)	3·0	
Figure 8 tie	Hygienist	3·8 (1·6)	4·0	0·018
	Orthodontist	1·0 (0·0)	1·0	
Canine lacebacks	Hygienist	5·4 (1·7)	5·0	0·11
	Orthodontist	3·4 (2·2)	2·0	
Archwires with elastic modules	Hygienist	19·0 (4·1)	19·0	0·008
	Orthodontist	4·8 (2·3)	5·0	
Rotation wedge	Hygienist	3·2 (2·2)	2·0	0·018
	Orthodontist	1·0 (0·0)	1·0	
Powerchain upper 2–2	Hygienist	2·0 (0·7)	2·0	0·065
	Orthodontist	1·2 (0·5)	1·0	
Archwires with quickties	Hygienist	19·8 (2·9)	20·0	0·009
	Orthodontist	9·0 (2·1)	9·0	
Kobayashi hook	Hygienist	5·4 (1·5)	5·0	0·014
	Orthodontist	2·2 (1·3)	2·0	
Berman ligatures	Hygienist	9·4 (3·7)	11·0	0·011
	Orthodontist	2·8 (1·5)	3·0	
Power chain 3–6	Hygienist	3·2 (1·1)	3·0	0·013
	Orthodontist	1·4 (0·6)	1·0	
Removal 2 archwires	Hygienist	5·0 (1·2)	5·0	0·014
	Orthodontist	2·2 (1·3)	2·0	

Conclusions

1. The ability of hygienists to carry out potential orthodontic auxiliary tasks on typodonts after appropriate training is supported.
2. Trained orthodontists are more efficient than newly trained hygienists in carrying out potential orthodontic auxiliary tasks. However, with increased patient contact this difference is likely to reduce.

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