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Video versus Lecture: Effective Alternatives for Orthodontic Auxiliary Training

MELISSA S. CHEN, M.SC., B.D.S., F.D.S.R.C.S., M.ORTH. R.C.S.

ELISABETH N. HORROCKS, B.D.S., F.D.S.R.C.S., M.ORTH. R.C.S.

ROBERT D. EVANS, M.SC.D., B.SC., B.D.S., F.D.S.R.C.S., M.ORTH. R.C.S. (EDIN.)

Department of Orthodontics, Eastman Dental Institute, Univesity of London, 256, Gray's Inn Road London, WC1X 8LD, UK

Abstract: *Many studies have compared the relative effectiveness of visually-aided lectures and videotapes, but methodo - logical flaws have prevented definitive comparison of the techniques. This study assessed the relative effectiveness of the two approaches for orthodontic auxiliary training. This study was a prospective, randomised trial, conducted at the Eastman Dental Hospital and Institute.*

Two groups of 16 dental auxiliaries, selected at random, studied identification and positioning of orthodontic brackets: one group attended a lecture accompanied by slides and the other viewed a video. Subjects bonded brackets onto acrylic teeth and the results were assessed by computerised image analysis. The subjects completed a questionnaire on their attitudes to the respective teaching methods. Results were assessed for accuracy of bracket placement and variations in type of auxiliary.

There was no significant difference between the teaching methods except for bracket positioning where video was slightly better ($P < 0.05$). There was no significant difference between the types of auxiliary.

Generally, video teaching and lecturing were equally effective, with video achieving slightly better results. Both methods were effective at teaching bracket placement, and dental nurses and student hygienists proved equally adept at bracket positioning.

Index words: Audiovisual Aids, Teaching Methods, Videotapes.

Background

Although orthodontic treatment in the UK is provided by three main groups, the General Dental Service, the Community Service and the Hospital Service, there is an acute shortage of manpower (O'Brien and Shaw, 1988). In recognition of the need to rationalise resources, it was recommended that in Britain the orthodontic working team should be expanded to include orthodontic auxiliaries (Nuffield Foundation, 1993). This would necessitate new training courses with appropriate instruction for the tasks to be undertaken.

In a recent survey of American dental schools, lecturing supported with visual aids, still seemed to dominate dental education (Cohen and Forde, 1992). Yet, while the lecture is a cost-effective teaching method in staff student ratio terms, offers flexibility and depth of content, and a platform for charismatic lecturers (Sinclair, 1972), it has a number of disadvantages. First, the sequence and pacing of presentation is determined entirely by the lecturer, second, the student remains passive (Beard *et al*., 1978), and third, lectures are not effective for demonstrating practical skills or detailed procedures (Hatton, 1988).

Teachers in medicine and dentistry have looked towards audiovisual aids to improve efficiency in instruction (Judge, 1968). Video has proved effective and flexible as a teaching aid for undergraduate and postgraduate education, within both medical and dental schools and as part of distance learning programmes where it has offered a number of key benefits (Mir *et al*., 1985; Wilson *et al*., 1993; Holt *et al*., 1994). These include more concise and better organised material (DeLuca, 1991), more efficient use of teaching time (Whittaker *et al*., 1989), and a visually effective presentation (Denehy, 1973; DeLuca, 1991), with the incorporation of motion, a particular advantage in learning perceptual-motor skills (Grundy *et al*., 1970). However, recorded media simply present material, providing little interaction (Guild, 1977), and are extremely costly to produce in terms of man hours (Gilder, 1989).

While, there are few studies comparing video and/or lectures for the teaching of orthodontics, other disciplines highlight conflicting results. Comparison of teaching methods is difficult due to varying student abilities and knowledge, and inconsistent performances from the teacher presenting the different media (Luffingham, 1984). It has been stated that studies comparing teaching methods are valid only if certain stringent conditions apply: students are assigned randomly, quality and performance of the demonstrators are identical, content of the lectures and the learning environments are the same (Chu and Schramm, 1967).

Paegle *et al.* (1980) found that a videotaped lecture could be as effective as a traditional lecture illustrated with transparencies, whereas Howell (1981a) found that for orthodontic teaching, a lecture was significantly better than a video. Both these studies may have been influenced by bias against audiovisual teaching. In a study where no

Miss M. S. Chen, 68, Colney Hatch Lane, Muswell Hill, London N10 1EA, UK.

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preferences were stated, gain in knowledge was found to be the same for a video and a lecture group, but for the practical assessment, the video group scored significantly higher (Beswick *et al*., 1982). In a large survey of educational research, Cohen *et al.* (1981) compared seventy four well-conducted studies of visual-based learning through meta-analysis. The majority of these studies found no significant difference between visual-based and conventional teaching, and in a typical study, students learned only slightly more from visual-based instruction.

Thus, as there is little research in the field of orthodontics with regard to the comparison of teaching methods, and in anticipation of training courses being set up for orthodontic auxiliaries, it is important to know which teaching method would be the most effective. This project looked at two commonly used techniques, the video and the visually-aided lecture, with the aim to compare their relative effectiveness in the training of dental nurses and student hygienists to place orthodontic brackets.

Materals and Methods

The effectiveness of each teaching method was assessed according to the accuracy of placement of pre-adjusted orthodontic brackets at the mid-point of the clinical crown of teeth, as described by Andrews (1976). Instruction was provided on the direct bonding of orthodontic brackets to model teeth either through a video or a visually-aided lecture. The 15-minute video included excerpts of a full bracket-bonding procedure both for a patient and a set of model teeth, carried out by a senior member of staff. It contained information on the identification, correct positioning and placement of pre-adjusted orthodontic brackets on to patient and model teeth using moving images, diagrams and a narrative. The 30-minute lecture was given by the senior member of staff involved in the production of the video, and contained the same information from the clinical and laboratory setting. The lecture slides were constructed from still pictures taken from the video and the diagrams were the same as those used in the video.

The sample size was calculated using data from two previous studies investigating orthodontic bracket location (Fowler, 1990; Taylor and Cook, 1992) and a statistical nomogram. Having set the power of the study at 0·80 (80%), 16 subjects were required in each group. Thus, a total of 16 dental nurses and 16 student dental hygienists were tested, with both the video and lecture groups consisting of eight dental nurses and eight dental hygienists. All the subjects were randomly allocated to their respective groups. The subjects viewed their particular teaching medium once, individually for the video and as a group for the lecture. A practical exercise of bonding orthodontic brackets to articulated model teeth was then immediately carried out (Oliver and Volp, 1991). The teeth were positioned in their model bases to the level of the cemento-enamel junction to 0·1 mm accuracy as measured with a pair of electronic digital vernier calipers. Each subject was provided with a set of 0·022 × 0·030-inch pre-adjusted edgewise brackets (Andrew's prescription; Dentaurum, Ispringen, Germany) correctly orientated on a bonding card. The subjects were given unlimited time to complete the procedure.

An image analysis system was used to analyse the vertical and horizontal bracket positions as well as the bracket slot angulation relative to the ideal position (Andrews, 1976) (Fig. 1). Images of the bonded teeth were captured using a CCD camera which was connected to an IBM-compatible 80486 personal computer, under the control of Optimas® computer software (Bioscan Inc., Edmonds, WA USA). A jig was designed to hold the teeth for the measuring procedure allowing each tooth to be positioned in the same location under the camera; a reference overlay image could then be used to measure the linear and angular errors. For the study, a calibrated examiner measured each bracket position once and a random set of teeth were measured a second time, 2 weeks later, to carry out an error analysis.

The accuracy of bracket identification was assessed by recording the number of brackets placed on incorrect teeth, as well as those placed in a rotated fashion. The number of subjects placing these incorrect brackets was also recorded. On completion of the bonding exercise, the subjects were asked to fill in a simple questionnaire to assess their attitude to the respective teaching methods.

The error of the bracket position measurements was assessed for total error by the percentage error of repeated measurements. Random error was calculated by the coefficient of reliability, and a one-sample *t*-test was undertaken to give an indication of the systematic error. The quantitative data was analysed using the SPSS statistical package (version 5·0; SPSS Inc., Chicago, IL USA). As all the data was found to be normally distributed, the standard deviation was calculated for each subject. The standard deviations were not found to be normally distributed, and comparative analysis was performed using the Mann–Whitney U-test. For the qualitative data, the Standard Normal Deviate was calculated to compare proportions within the study.

Results

The random, systematic, and total error of the bracket position measurements were not significant, and so the data

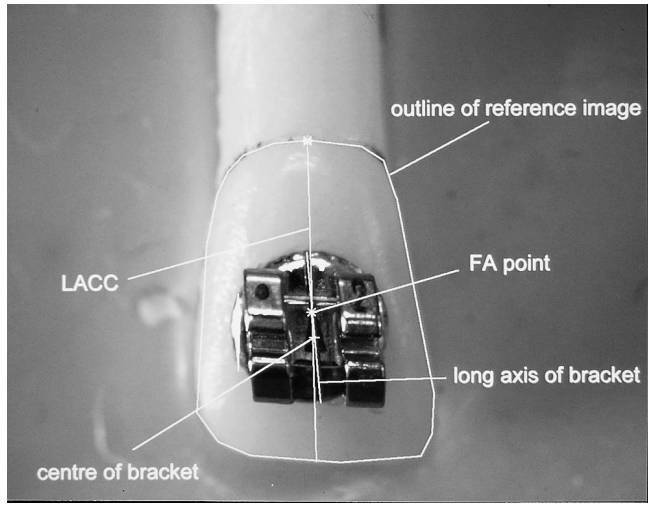

FIG. 1 View of upper right lateral incisor and bracket with superimposed reference image used for computerized analysis.

was used to compare the teaching methods through two methods of analysis. According to the number of subjects who placed brackets outside arbitrary tolerance figures (Andrews, 1976), for both teaching methods, more subjects were able to place brackets within the 0·5 tolerance value in the horizontal as opposed to the vertical direction. The most errors occurred with the angular bracket positioning, with the highest proportions falling outside the 2·0 degrees tolerance angle (Table 1). For each of the confines investigated, there was little difference between the teaching methods leading to non-significant Standard Normal Deviate values (Table 1). Comparison of the teaching methods assessed using the standard deviation of the bracket positions for each subject revealed that for horizontal and vertical positioning there was no significant difference between the methods. However, for the angular bracket placement, video teaching was better than lecturing at the 5 per cent significance level (Table 2).

As different types of subjects were involved in the study, dental nurses and student hygienists were compared, again using the standard deviation of the bracket positions for each subject. There was no significant difference between the groups for any of the bracket positioning measurements. The teaching methods were compared through the number of incorrect brackets placed by the subjects in each group, as well as the number of subjects placing those incorrect brackets. The number of incorrect brackets placed due to poor bracket identification was small in relation to the total number placed in each group. Thus, although the Standard Normal Deviate revealed a significant difference between the teaching methods according to incorrect bracket placements, video achieving better results (SND $\geqslant$ 1·96), in practical terms the proportions within each group were very small. According to the number of subjects who placed incorrect brackets, again the Standard Normal Deviate revealed a significant difference between the teaching methods, with video achieving better results (SND $\geqslant$ 1·96). However, most of the subjects placed the majority of brackets correctly.

The proportions of subjects indicating favourable responses from each of the questions in the questionnaire were compared. None of the Standard Normal Deviates for the difference between these proportions verified findings as significant (Table 3).

Discussion

Comparison of the teaching methods was carried out by two different methods of analysis. Both according to the proportions of subjects placing brackets outside tolerance limits and the standard deviation of the bracket positions, there was no significant difference between video teaching and lecturing with respect to the horizontal or vertical bracket positioning carried out by dental auxiliaries. There was only a slight discrepancy for angular bracket positioning where the second method of analysis revealed that video teaching produced better results at the 5 per cent level (Tables 1 and 2). This is similar to the findings of other studies (Paegle *et al.*, 1980; Cohen *et al.*, 1981; Beswick *et al.*, 1982). Angular bracket positioning may have been more sensitive at identifying a difference in the effectiveness of the teaching methods. However, in real terms, this difference was of the order of 1 degree which would be difficult to detect clinically. When taking into account the amount of error for angular measurements, the significance of the difference reduced further.

The reason that video teaching was better than visually-

TABLE 1 *Comparison of the proportions of subjects who placed brackets outside tolerance limits for the video and lecture groups*

No. of subjects who placed brackets outside tolerance limits (of 16)		Difference between proportions	95% Confidence interval for difference	Standard normal deviate (Z)
Video	Lecture			
Horizontal (fewer than 4 brackets)				
13	14	0·0625	−0·189 to 0·314	0·487*
Vertical (fewer than 4 brackets)				
8	12	0·25	−0·0855 to 0·585	1·461*
Angular (fewer than eight brackets)				
10	5	0·3125	−0·0333 to 0·658	1·771*

* SND < 1·96, not significant (NS).

TABLE 2 Comparison of the standard deviation bracket positions between teaching method groups using the Mann–Whitney U-test

Variable	Number of subjects	Mean standard deviation		P-value (exact)	P-value (corrected for ties)
Horizontal bracket position	32	Video	0·4245	0·4016	0·3860*
		Lecture	0·3672		
Vertical bracket position	32	Video	0·5318	0·0513	0·0500*
		Lecture	0·4395		
Angular bracket position	32	Video	3·4065	0·0189	0·0195**
		Lecture	4·0131		

* $P \geqslant 0{\cdot}05$, not significant (NS).
** $P < 0{\cdot}05$, Significant (SIG).

TABLE 3 Comparison of the proportions of favourable responses in the questionnaires of the video and lecture groups

Question	Number of subjects responding favourably (of 16)		Difference between proportions of favourable responses	95% Confidence interval for difference	Standard normal deviate (Z)
	Video	Lecture			
1	13	9	0·250	−0·071 to 0·571	1·525*
2	14	12	0·125	0·542 to 1·083	0·906*
3	14	14	0·000		0·000*
4	13	10	0·188	−0·124 to 0·499	1·180*
5	5	5	0·000		0·000*
6	3	8	0·313	−0·017 to 0·642	1·861*
7	9	6	0·188	−0·158 to 0·533	1·063*

* SND $<$ 1·96, not significant (NS).

aided lecturing for angular bracket positioning may have been due to the fact that motion was incorporated into the video demonstration, an advantage in learning skilled perceptual-motor acts (Grundy *et al*., 1970). For the linear dimensions, the concept of bracket positioning was relatively easy to explain, that is, at the centre of the tooth crown. However, correct angular placement of brackets involved the location of the long axis of the tooth crown, a line not always simple to visualise. The idea of angular bracket positioning may have been more difficult to visualise from still pictures even though equivalent images were used. Dissimilarity in content has been cited as a problem in previous comparisons of teaching methods (Chu and Schramm, 1967). In this study, although every effort was made to ensure the teaching methods contained the same information, the nature of video is such that more peripheral information may be conveyed through a medium where visual effects can be maximized. This also may have led to marginally better results from the video instruction.

An advantage of video teaching is the facility for play back which allows students to review part or all of their teaching material as often as necessary, making learning flexible (Howell, 1981b; Mir *et al*., 1985). Although repeated viewing of the video might have been of additional benefit, the subjects were restricted to viewing the video once only to make the teaching methods directly comparable.

Having conveyed the information only on one instance, either through a single lecture or one viewing of a video, both methods of instruction were effective at demonstrating the concept of bracket positioning. This was revealed by the small number of subjects in each teaching group who placed more than half their brackets outside tolerance limits (Table 1).

As the results revealed there was no significant difference between the subject types for any of the three bracket positions, it is likely that in the future, orthodontic auxiliaries may be selected from either group with equal success. In this study, two types of subjects were used, as insufficient dental nurses met the selection criteria of having no post qualification orthodontic experience. Student hygienists were selected as they had equivalent qualifications and no orthodontic experience. The additional intra-oral skills of the student hygienists gave them no advantage over the dental nurses; however, the exercise was carried out on standing models rather than on models set in a phantom head or in the true clinical situation.

Due to the small number of misidentified brackets placed and the small number of subjects placing incorrect brackets, neither of these tests were sensitive indicators of the effectiveness of teaching methods. From the responses of the questionnaire, it was evident that video teaching would be as acceptable as visually-aided lectures for the teaching of orthodontic skills to dental nurses and student hygienists.

Conclusions

Accepting the limitations of this study, the following conclusions were drawn:

1. Generally, video instruction was as effective as a visually-aided lecture in teaching bracket positioning to dental nurses and student hygienists. However, video instruction was better than lecturing according to the standard deviation of angular bracket placements. This difference was statistically significant, although not clinically significant.
2. Video instruction and a visually-aided lecture were effective methods of teaching bracket placement.
3. Dental nurses were able to position orthodontic brackets as effectively as student hygienists and thus, in future, orthodontic auxiliaries could be selected from either group with equal success.

In addition to the main findings, and related to the study aim:

1. Angular bracket positioning may have been more sensitive in identifying a difference in effectiveness between video teaching and lecturing, as ideal bracket positioning was more difficult to achieve in this direction compared to vertical and horizontal bracket placement.
2. Both groups of subjects found video teaching as acceptable as visually-aided lectures for the teaching of orthodontic skills.

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