New approaches to the Begg technique

Part I - Qualitative Aspects

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Abstract: The development of new materials and wires has allowed the creation of new mechanisms. These include new aligning and torqueing wires which provide gentler pressures yielding rapid tooth movement. Different finishing systems are available with different purposes. There has arisen the need to formalise treatment planning using a Visualised Treatment Objective and to document post-treatment changes cephalometrically. These various factors dictate a new look at traditional Begg teaching.

A single paper cannot provide a comprehensive coverage of an orthodontic technique, so this selected coverage must be supplemented by a formal coverage of the Begg technique in particular, and orthodontic education in general, as found in Master's courses in Australia. Since this technique part of twin papers is qualitative in nature, the format for rule-based Expert Systems has been utilised, which is discussed in the Editor's newsletter of this issue.


MeSH words: Orthodontic appliances; malocclusion/therapy; dental records; cephalometry; bonding; education/dental/continuing; expert systems

Key words: Begg technique, ultra fine high-tensile wires, twisted wires, treatment planning, post-treatment changes, retention, bonding, Glass Ionomer cements.

INTRODUCTION

The following quotation comes from a book on the Theory of General Relativity written by a professor of physics and mathematics, but it has obvious applications to orthodontics. It introduces the first of four recurring attitudinal themes found in this paper.

'The view has somehow become rampant that such theories (of physics) are precise, highly logical, ultimately "proved". But rather they consist of an enormous number of ideas, arguments, hunches, vague feelings, value judgments, and so on, ... connected in a complicated way in a "nebulous mass taken as a whole". In presenting a theory, however, ... one is forced to arrange it so that it is linear. What is supposed to happen is that one who learns the theory, presented in this linear way, then proceeds to form his own "nebulous mass taken as a whole".' ...... Robert Gerach (1978)

1. Relationships must be identified

Many examples abound in orthodontic treatment to support the theme of creating useful relationships between various parts of the treatment.

An example of such interrelationships may be presented in the following 'If-Then rule' as used in Expert systems. Expert system rules are discussed in depth in the Editor's Newsletter at the rear of this issue of the journal, and are presented in this article in italics following a small square.

* If finishing archwires are used routinely, then one learns considerably more about bracket positioning and adhesion in bonding and bonding.

One can thus build back into the original placement of the appliance features to intercept problems occurring in the finishing stage. A more specific 'rule' would be:

* If offsets are frequently needed in the lower finishing archwire to elevate the lower cuspids, then the brackets on these lower cuspids should be placed more gingivally in the first instance.

Also,

* If brackets frequently break off when rectangular finishing archwires are jammed into the slot with steel T-pins, then the bonding strength needs to be increased to reduce this problem.

Similarly, observations in the retention phase can be fed back to treatment plans in subsequent cases. This provides a rule of a more biological nature.

* If one has problems in a number of cases controlling relapse of extremely rotated incisors in retention, then this may lead one to consider either pericision or early treatment, as well as the usual Begg overmovement.

Furthermore, where the dentition is placed, is determined on a hindsight basis from similarly previously treated cases. Until one has a sufficient core of completed cases to analyse and criticise, then one must resort to a type of "cookbook" approach.

Such relationships closely follow 'non-linear reading' which is discussed in the Editor's Newsletter in this issue. Table 1 is provided to label the superscripts for this article for those interested in the application of non-linear reading.

Non-linear reading table (see Editor's Newsletter)
(The numbers are found in the text as superscripts)

| 1. | self monitoring |
| 2. | inter-relationships |
| 3. | compatibility |
| 4. | differentiation |
| 5. | occlusal disfunction |
| 6. | finishing |
| 7. | expert system |
| 8. | observability theory |
| 9. | long term results |
| 10. | reliability and consistency |
| 11. | linear reading |
| 12. | iatrogenic problems |

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2. Details are important

The more experience one has, the more one appreciates how important the many details are in the successful completion of cases. Obviously, a .016" x .022" finishing archwire cannot be placed in an Edgewise mode in a Begg bracket slot which does not have sufficient room for it. Some brands of Begg brackets will only allow the insertion of a .019" x .019" wire, or an .018" x .025" wire in a ribbon arch mode. Such differences between brackets must be learnt to complete transfer patients. These are technical details of an immediate nature. Other details may have longer term effects —

- If arch length tends to contract with time (Little, 1987) then correct contact points are important for stability, including those between molars.

3. Careful planning is worthwhile

Each procedure has its advantages and disadvantages, and one must select on the basis of what one judges to be the optimum procedure for that individual patient. For example, if the clinician is entertaining the extraction of the upper first molars as advocated by Williams (1979), then firstly he needs to look carefully at all the factors or variables pertinent to that procedure. A second type of rule may express this —

- Variables (or factors) related to extraction of upper first molars are: the requirements of the lower arch (e.g. no crowding and only lower anterior intrusion), the upper anchorage requirements, relation of these anchorage requirements to the size of the roots of the upper second molars, the strength of the bite, the oral hygiene standard and the anticipated care of the unsupported upper archwire.

The problems with the extraction of first molars in brachyfacial adults with strong biting forces, are mobility and flaring of the second molars. These would have been the reasons why Dr Begg introduced the flat oval tube.

Concern about any one of the factors mentioned in the rule in this section could be sufficient to make one reconsider the procedure and request extraction of premolars.

4. Self criticism is essential

It was said of Dr Begg by a colleague who knew him well, that the reason Dr Begg found it difficult to take criticism from other people was that he was so self critical of his own treatment methods. Not all criticism by others or ourselves requires dramatic changes in one's thinking, but when a point continually arises, then it ought to be taken seriously. This can run the whole gamut of our therapy. It can come from younger patients who may suffer from stomach upsets following bandings, especially if analgesics have been given (short term), to parents who are concerned about the profile after treatment (long term).

It is a fact of life that once one becomes aware of a phenomenon or has it pointed out, it is amazing how frequently it is noted thereafter. A good example is occlusal dysfunction resulting from non-working side interferences.

> Beware that one does not hide beneath the umbrella of routine instructions to obscure the observation of tell-tale signs of occlusal dysfunction.

In the past, almost routine extractions of premolars provided sufficient room for the upper second molars to erupt quickly into position and natural torque was produced by the occlusion to reduce the vertical extrusion of the palatal cusps. However, astute clinicians realised that this advantage could be undone by over-extraction. For example, the extraction of first premolars were indicated produced a triad of problems — compromised profile, re-crowding and occlusal dysfunction. All three resulted from the inability to place the whole dentition sufficiently forward when it was required.

So extractions alone was not a panacea for occlusal dysfunction. If the Begg clinician listened sympathetically to all his patients, there was the occasional one who reported TMJ symptoms from upper molars. Trimming or tucking in upper second molars with a piggy back arch relieved the symptoms immediately, so they were most likely the cause. Furthermore, when Dr Ronald Roth pointed out the association between flattened cuspid cusps with occlusal dysfunction on the other side, it was somewhat to our surprise that we started to see this phenomenon occasionally in our own cases — sometimes even during active treatment.

A distinct advantage of continually reading the orthodontic literature is that practitioners can be alerted to possible problems.

**DIAGNOSIS AND TREATMENT PLANNING**

It is necessary to know as much about the patient as possible to make a good assessment. The skeletal, dental and soft tissue morphology may be recorded and evaluated on cephalograms. The analysis may be done in a graphic manner, or one may measure lines and angles to compare them to standards.

These standards are particularly important when the features are beyond normal variation requiring assessment for orthognathic surgery. Such standards ought to be kept in perspective by remembering to look at them from the point of view of age and race. Examples of the availability of standards for age are the Bolton standards; and the St Louis University's "analytic template" as supplied by Dr. Lyle Johnson when he visited Australia some years ago. Figures for 9 and 19 years are available from the Melbourne Growth Unit under the directorship of Dr B. Darrelle Bowden. Other numeric standards as supplied by Ricketts, McNamara and Owens (1984) are well known. Standards for various racial profiles are also available to us from, for example, Foo (1986), for the Chinese.

**Developmental status**

Many prominent Begg practitioners, such as Mackie (1983) use a clinical assessment of growth and development. However, there is a simple way to combine development assessment with a cephalometric film according to Mollenhauer (1984).

> If one is prepared to accept a reasonable image of the medial and distal phalangeal maturity indicators, superimposed on the cephalometric radiograph, then the patient's fingers are placed upon the soft tissue shield.

The disadvantage of this method is that one does not have other indicators such as the ulna sesamoid, hamate and pisiform indicators for confirmation. The advantage is that the patient is not exposed to further radiation and hence it can be taken with all subsequent cephalometric radiographs, such as those for the pre-filing and follow-up radiographs. Naturally, the image is not as clear as one sees using a standard Hand and Wrist plate. After some practice at comparing the images with the chart supplied by the Child Growth Unit of the University of Melbourne, it only requires several seconds to identify the skeletal stage. It is a pity that Demirjian et al (1985) did not include the medial and distal phalangeal indicators in their study, because this phenomenon has been observed by the author. When the medial and distal indicators are not consistently different in stages, the patient usually has Class III features. That is, it is as if the medial phalangeal indicator relates to the maxilla and the distal indicator to the mandible.

For those who are restricted to a clinical evaluation, as in country branch practices, then the paper by Baume et al (1983) may be of help. They found that the body stature is of greater importance than head height in the prediction of vertical facial growth. As shall be seen later, the late growth in the vertical dimension of high angle or dolichocephalic types is particularly significant to treatment planning to counter lack of incisal guidance for posterior discission. The most obvious rule for the use of developmental indicators is:
If a pre-adult Class III case is to be treated, then it is mandatory to use development indicators to ascertain if further mandibular growth is likely to effect the prognosis. It is considered not good practice to undertake normal fixed appliance therapy if there is a strong chance that the patient will require orthognathic surgery in the future.

**Cephalometric equipment**

For those who are contemplating installing cephalometric equipment, or will be consulted on the installation, several points are worth noting.

* If a radiograph is taken then, in the interests of radiation hygiene, it should yield the most information possible.

Despite the use of Rare Earth films and screens, cephalograms need more powerful X-ray machines than normal dental machines. They should be taken with a minimum of 90kv.

Many cephalometric films which are seen in this country are inadequately exposed to clearly see the internal structures and the teeth. It is wise to increase the exposure until the optimum images are produced, as seen in a dark room.

There is a trend towards taking natural head position cephalograms to utilise the work of Solow (1984). One may use his suggestions as discussed by Cannon (1985), or use the technique suggested by Showfety (1983).

A second trend is to use grids selectively to produce better images of the condyle and porion area (O'Ryan and Croall, 1987).

* If the trouble has been taken to expose a film in the best possible way, then attention to detail in the darkroom is equally important.

Two points to bear in mind are the safety light covers and changing of developer. After a number of years the covers may crack, letting through white light which fogs the film. This may be difficult to detect if the light faces the ceiling. Rare earth films require more frequent changing of the developer. Poorly exposed, developed and traced cephalograms have been said to be a 'treasure-house of misinformation.' Digitised cephalometrics have the potential for even more error.

Prior to tracing, the film should be viewed for pathology in the manner described by Kantor and Norton (1987).

**GRAPHIC TREATMENT PLANNING**

**(a) Vertical dimension**

Experience from analysing my cases prior to routinely using a VTO, and subsequent confirmation from analysing transfer cases, points to the inadequacy of the traditional Begg “cookbook” approach to the vertical dimension. Each case requires its own directions and amounts of vertical movements of the incisors. It is quite wrong to use an average of past treated cases. It is necessary to contemplate quietly all the factors and use trial drawings if necessary to formulate a treatment plan for each patient. (Mollenhauer, 1986)

* Variables related to the vertical dimension are — lip line, lip competence, growth, lip line rising with incisor retraction, mandibular rotation, lower lip caught under upper incisors, upper lip thinning vertically with upper incisor intrusion.

A perusal of Figures 2 and 3 will help apply this rule and thus explain the procedure, for easier understanding and personal application. Those familiar with Holdaway’s writings will note that lip strain has not been included in the list of variables, because it is assumed that the lips have been exposed at rest rather than together.

Obviously there will be variations from individual to individual but treatment planning may be likened to
budgetting initially, followed by a cash-flow analysis, wherein the forecast is reinforced or not by subsequent tracings. Documentation, to fine tune one's judgment objectively, is essential.

The case in Figure 1 still had further growth to be realised. Therefore from the study by Vig and Cohen (1979) and personal observation one could expect the lower lip to grow several millimetres in relation to the mandibular symphysis. That is, the lip line will probably rise to the dotted projection. The upper incisor is already too low for this patient's lip line, thus, for normal expectations, the 1 will need to be intruded considerably, as indicated by the dotted outline of 1.

If treatment dictates upper incisor intrusion, then mechanics should start with optimal intrusion from the outset with either SHS s or tube elastics such as 1--1½oz.

These light elastics are produced by instructing the patient to stretch 2oz elastics before placement. Concomitantly, the lower incisor should be extruded for this patient. If the lower first premolars do not require removal, then their brackets could be engaged by the archwire from the outset to minimise intrusive effects on the lower incisors.

Variables related to minimising intrusion are:

- * engagement of brackets of first premolars, use of T-pins and 'S' curves, reduction of anchorage curves where the anchorage allows it.

'S' curves are discussed later. If the degree of crowding is minimal, T-pins may be considered early in Stage I on the lower incisors in Figure 1 type of cases. Conversely, for the patient in Figure 2, the upper incisors require extrusion to be brought down under the influence of the lower lip —

- * if the 1 requires extrusion, then a lighter archwire such as an .016" or even an .014" wire (if the anchorage will tolerate it) should be employed with less severe anchorage curves, and heavier Class II elastics (e.g. 3oz) and possibly vertical elastics applied.

In this second patient the lower incisors require considerable intrusion —

- * if considerable lower incisor intrusion is required, then a non-distortable lower archwire is required. A lower archwire configuration called a Bypass archwire, which minimises the possibility of distortion, will be discussed in detail under archwires².

Beware of round tripping in the vertical dimension.

Both intrusive (Dermaut and De Munck, 1986) and extrusive movements have been implicated in root resorption³. Therefore, the best possible planning should be undertaken from the available evidence, to minimise changes in vertical directions. Root resorption is enhanced appreciably by jiggling. The management of intermitten elastic wearing is not easy because the clinician invariably hopes that the patient will cooperate.

- * if a case with an overjet of less than 12mm and extreme overbite or openbite has not finished Stage I within twelve months due to inconsistent elastic wearing, then radiographs to check on root resorption would be justified.

Unresolved questions are when and how to reduce mild open bites conservatively. Common clinical observation indicates that 'bitses jack open' mostly in the first few months of treatment. Therefore, a case with indicators of backward rotation could be considered for anterior vertical elastics in the first few months of treatment. For example, a dolichocephalic case with no overbite and high canines to be brought down would be such a candidate. There are cases with insufficient overbite present in the finishing stage. Research is required to establish whether light or heavy forces are preferable for efficacy and to minimise root resorption. One of the advantages of Rickett's "squeeze" technique could be that jiggling is minimised compared to using single light anterior vertical elastics which may not be worn consistently over the longer period required.

Other problems of insufficient overbite as typically found in dolichocephalic or high angle cases will be discussed later under 'Clinical assessment aided by study models'.

(b) Horizontal dimension

Whilst teaching in the vertical dimension has not been specific enough in the past, teaching in the antero-posterior dimension in the 60's and 70's was undoubtedly wrong in that there was an over emphasis on extraction and anterior retraction "onto basal bone." One problem was the fact that there was a cookbook approach to this without rational selection of extractions. The other problem is that the anterior teeth exhibit distal migration relative to the symphysis, indicated by the internal surface of the lingual cortical plate and superpogonion, following treatment in most cases, even non-extraction cases. These problems earned such terms as 'the Tweed face', and 'the Begg face'. Mills (1968) research had an unfortunate influence on the orthodontic community in this country, whereas being more relevant to general practitioners, orthodontists for which the Diploma of Orthodontics was intended (R.C.S., 1987). Mills' study was too short term, because it may take three years, post-treatment, to convincingly elicit the usual distal movement of the lower anteriors, which is invariably BODILY. Even more importantly, the anteriors only rarely recover forward from over-retraction in the normal time dimensions of full treatment and retention.

- * if the lower anteriors distalise post-treatment, then the clinician should decompensate for this developmental phenomenon so that the patient's face is not pre-aged.

Peck and Peck (1971) discuss pre-aging of the face.

- * if the anterior teeth are over-retracted then it is possible that the lips can exert more force and thus cause greater crowding, as well as compromise the profile².²

Mills' more recent paper (Looi and Mills, 1986) should also be answered. The contention of this paper is that the choice of extractions does not matter. Such a conclusion may be reached from students' cases but experienced practitioners who become adept at anchorage control would find this idea difficult to concede, especially when the cases are carefully monitored cephalometrically.

The findings of Williams and Hosila (1976) also negate Mills' hypothesis. Furthermore,

- * if the anteriors are found to be considerably too distal on a pre-finishing tracing, then a repeat pre-finishing tracing taken several months after protraction mechanics can be quite disappointing, and a post-treatment tracing positively infuriating.

Another dogma which should be evaluated personally by every specialist orthodontist is that the distally placed apices of the lower incisors at the end of Begg treatment will move forward due to the occlusion (Fletcher, 1981). The fact is that careful tracing of most cases out of treatment (preferably 5 years) will show that the apices distalise even more relative to the symphysis. One could speculate that this is due to the cicatrisation of the transseptal fibres in extraction cases, even third molars extraction cases. One occasionally sees this distalisation of apices on the buccal teeth which may be one reason why Ricketts has recently decided not to cover upright the lower cusps.

But younger practitioners should —

Beware of an over-reaction against extractions, influenced by a previous generation's reaction to non-extraction, to an even earlier generation's reaction......

The answer to this is routine use of the Visualised Treatment Objective, as described later, to ensure a treatment plan tailored for the needs of each patient.
Another point to consider carefully is the statistics of the ratio of extraction cases to non-extraction cases. One needs to differentiate between those which were started non-extraction but became extraction cases and those which did not. A number of cases can start non-extraction but due to the bite 'lacking open' necessitate extractions. These are not always dolicho-facial types.

The impetus for re-evaluating the 'cookbook' approach to overzealous extractions came from the longer term effects on the soft tissue profile as well as the dental tissue mentioned above. It was pointed out in a personal communication to the author by Dr Raleigh Williams that thick lips did not respond to tooth movement as much as thinner lips. This was subsequently confirmed by Oliver (1982) and by Holdaway (1983) that an absolute value occurs at about 18mm wherein little change in the lip profile occurs, irrespective of the amount of tooth movement. This raises the proposition —

> If a bimaxillary protrusion case has very thick lips, then it should not be treated for profile reasons alone.

However, the majority of cases have much thinner lips 4 mm, and the potential for excessive 'vertical' response, then the parents must be warned that, some years after conventional treatment, the profile may be worse.

Obviously this has important implications for specific cases —

> If a patient has an excessive overjet, an obtuse nasolabial angle, thin lips, and the potential for excessive 'vertical' response, then the parents must be warned that, some years after conventional treatment, the profile may be worse.

(c) Lateral dimension

One hears a commonly expressed assumption in Begg meetings that, when lower cuspids are retracted into the premolar sites, they may be expanded and be stable; because they have been distalised into a broader part of the arch. All studies on this subject read by the author have failed to confirm this assumption. There has not been the rigorous teaching of archform in the Begg technique as there has been in the Edgewise technique. This could have resulted from the Edgewise experience of treating more non-extraction cases which require more finesse during Stage I and more fastidious finishing. Certainly, arch coordination may be more of a problem in Begg as the clinician graduates into more non-extraction treatment.

A suggestion for handling non-extraction cases is found under 'Archwires' later. Also:

> If the trend towards more routine use of rectangular finishing archwires occurs in the Begg technique, then more formal attention will need to be given to the archform objective and archform monitoring.

Archform relates to stability. Stability is also considered by some practitioners to be related to occlusal function. This may be considered in the lateral dimension because of the importance of buccal root torque as discussed in more detail under 'Clinical assessment aided by study models'. The problem of molar torque can usually be intercepted by early expansion of buccal crossbites. With fixed expanders, not only can buccal root torque be incorporated, but with vertical growth still to be realised, the molars frequently upright probably due to the forces of occlusion. Since this natural uprighting is most likely to occur with brachyfacial types, all dolicho-facial patients with buccal crossbites, especially with minimal overbites, should be considered for early treatment. For palatal expansion, bands are required only on the first permanent molars, or deciduous second molars if the permanent molars are not sufficiently erupted, and .030" chrome cobalt wire soldered to them in a 'W spring' configuration. It is most effective, provided the wire is heat treated before cementation (Figure 3). Rapid expansion is used by many Begg practitioners, but the timing is equally important.

Also in the lateral dimension one should consider the position of the upper cuspid apices:

> Differentiate between the requirement for the cuspid apices to be in the alveolar trough during tooth movement, and that requirement to recreate the canine eminence for finishing.

This may seem to be more relevant to the Edgewise technique — particularly the straight wire or pre-torqued variants. But it is also applicable to Begg. Firstly, there are some cases which require the roots of the upper cuspids torqued in, even in Stage I to allow easier retraction of these teeth. Oddly, this can be done simultaneously with the retraction of the anteriors (Figure 4). Secondly, occasionally the cuspid roots benefit from some palatal root torque in Stage III to enhance uprighting movements, that is, to move the apices away from the denser cortical plate. This is easily achieved with a full mouse trap torquing mechanism which includes the molars (Figure 5). Thirdly, and conversely, in the finishing stage, upper and lower cuspids should have the roots torqued buccally for stability (Williams, 1985) and aesthetics, as found from early cuspid transplant work. In fact, with the trend to more adult treatment, this canine eminence is becoming increasingly significant for the adult female who is particularly careful about her appearance. Such patients may express concern before starting treatment that they do not wish to finish with a sunken in appearance below and lateral to the nares. Certainly, palpation of thin lipped patients in this area confirms the importance of the canine eminence to the contour of the soft tissues here. Also, it is particularly important that the roots of upper cuspids, which had been exposed into the palate, be brought out buccally and retained for some time. However not all authors (e.g. Ricketts, 1978) agree with placing the lower cuspid and lateral apices buccally, due to functional considerations.

![Figure 4a](image1.png)

Figure 4(a). Simple torquing mechanism which utilizes its memory to revert to this degree of activation to apply a torquing force to the teeth — preferably more than two teeth apart.

![Figure 4b](image2.png)

Figure 4(b). When engaged, the ends provide pressure above the brackets of the upper cusps to torque their roots in. This temporary mechanism, rather than allowing overjet reduction, actually enhanced it. The roots were exceptionally prominent when the mechanism was initially applied.

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Begg practitioners have been led to believe that, for stability, all that is required is some overmovement, even for torque. This may apply to most crown movements and torquing of the upper incisors. However, Reitan’s work (1985) which showed that apical fibres take more than 2 months to reorganise, applies particularly to upper molar and lower incisor apices in torque, and upper laterals, especially small ones, for uprighting. In other words, *if one moves the apices of upper molars, lower incisors or small upper laterals, then they should be retained with the fixed appliances for at least two months.*

Clinical notes are not sufficient to confirm this rule — study models and cephalograms are required.

(d) Dimension of time
Various studies have shown that approximately 10% of patients benefit from early treatment using traditional methods. Even those who have considerable experience with functional appliances are said to find that less than 20% benefit from this form of therapy.

The author’s definition of those malocclusions which merit consideration for early treatment has previously been given (Mollenhauer, 1985 p253). In general, the principle behind this listing is the improvement of the prognosis, even if further treatment is necessary on full eruption. A self discipline to fine tune this judgment is to reduce the second fee by the amount charged for the first treatment. Such an arrangement also gives the parents confidence in early treatment.

An observation is that dolichofacial cases exhibit less backward mandibular rotation in Begg therapy when treated away from the pubertal growth spurt period, especially years after. If there is a choice in timing the treatment of such cases, this phenomenon could be taken into account. This principle would be also particularly relevant for those cases which concomitantly present early with microrhinodysplasia. The latter cases should certainly be considered for early orthopaedic therapy to reduce the incidence of root resorption which is regarded as being associated with that condition, which is recognised clinically as a turned up nose. Dr Begg’s humour was legendary and one of his quips was ’X-rays cause root resorption — if you don’t take X-rays, you don’t see root resorption!’ Indirectly but forcefully he was saying that it is important to monitor for iatrogenic sequelae, which is why Begg societies and study groups insist on post-treatment radiographs.

Stage I Begg treatment can be undertaken when deemed necessary at an early age using the deciduous molars as anchor teeth (Figure 6). This procedure was learnt from visiting Dr Begg’s practice.

(e) Graphic Analysis
The essential ingredients for tracing cephalograms must be observed, namely, a well exposed film, a dark room, black masking of other areas not being traced and study models present to help with the dental outlines and relationships. A constant and large volume of tracings provides the opportunity to develop personal conventions of which surface of each image to trace, so that consistency is achieved. This becomes important for superimposition later. It is not uncommon for students to have to retrace their films by the end of the course. In fact,

*If a clinician does routine follow up tracings for superimposition, then a check on tracing consistency will be provided periodically because a percentage of patients will not have grown.*

Currently, there is an explosion in the use of graphics in computers. This interest has been applied in many fields. For example, a graph showing the fortunes of a business is more easily and more quickly comprehended by the manager than tables of figures. Similarly, as much use should be made of graphics as possible for clinical use, such as in cephalometric analysis. For example, the correction of the lower incisor is more readily seen by including the aim with the ’present’ position. The present position may be a pre-treatment tracing or an in-treatment tracing such as a pre-finishing tracing, as in Figure 7. From a mathematical viewpoint, superimposition using one or more lines has more validity than using only two points. Compare the validity of the superimposition of the maxilla using the palatal outline, anterior and posterior outlines and the infratemporal lines all together, with using only ANS and PNS, as may be used with digitising*.

*If superimposition is to be used, then as many lines related to the structure as possible should be traced.*

Ideally, such graphic information should be complemented by numeric information, for inclusion in a database to enable numeric analyses of groups of cases. Also, one must use some numeric indicators for clinical purposes — for classification purposes or to limit
are a starting point for contemplation: Facial axis, craniocervical angle (CVT-SN), mandibular arc, lower facial angle or gnomon, TI angle. The averages are 90°, 104°, 26°, 47° and 54° respectively. These are supplemented by the Articulare to PT point measurement which is usually less than 35mm for a backward mandibular rotator in the younger patient.

**Xi finder**

To help find Xi point, on which the mandibular arc and lower facial angles are dependent, use the aid (Figure 9) in the manner prescribed in the illustration. This can yield quite a different Xi point from eye-ballng, especially in dolicho-facial types. In fact, colleagues who have used this template believe that it establishes a more valid centrepoint than the traditional construction.

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**XI finder template**

1. Place the Xi finder under the tracing + the radiograph attached.
2. Parallel the Frankfort-Horizontal indicator-line on the template with the FH line on the tracing.
3. While maintaining Step 2, move the tracing about, over the Xi finder, so that the rectangular lines are equidistant from R1, R2, R3 and R4 (Ricketts’ points).
4. Mark Xi point on the tracing by copying the cross in the middle of the rectangle.

If the clear template has already been removed, photocopy the column intact onto an A4 transparent sheet. It is important to copy onto a lengthy transparency sheet to be able to hold the template stable at the bottom where it protrudes below the tracing, while moving the tracings over it for appropriate superimposition. Therefore, cut off the excess transparency FROM THE SIDES ONLY.

(f) **Visualised treatment objectives**

An old proverb states ‘Those who don’t know where they are going will surely finish up just there.’ A similar one is ‘For those who do not know where they are going, any way will do.’

The advantage of a tracing and study models is that one can sit down away from the distractions of the clinical area to quietly contemplate all the variables related to each case. Positions of the teeth can be drawn in for long term objectives and the most likely lip responses can also be pencilled in. If the combination is not satisfactory, the dental outlines can be erased and redrawn. This is surely preferable to spending 2-4 years treating and retaining a patient, and then being sorry about the treatment objective.
Most parents of patients can be made to see the advantage of a detailed treatment plan by using the following statement 'If one wishes to drive to Adelaide from Melbourne, there is little point in driving north for two days — and then looking at the map? In the 1980s the question of extraction or non-extraction is irrelevant — the issue is where to place teeth. There is another practical advantage to a VTO.

If the correct extractions (or no extractions) are provided by the VTO, then 4-6 months of treatment time can be saved at least.

Space wasting to bring posterior teeth forward, when the case has been over-extracted (too much or too far forward), is very time consuming.

From a practice management point of view, it is not efficient to re-plan the treatment objective at each visit. That is, it is more expedient to spend a half hour initially, and proceed towards that objective from the outset. Of course, occasionally the plan needs to be changed in the light of new circumstances. But this becomes less frequent with the experience of criticising more cases, and the more careful one is in diagnosis and planning.

If a cephalometric VTO is used routinely, then it becomes a valuable self teaching device, by having to set an aim, to document it, to see if and how the aim is achieved, and to evaluate the aim long term to test its validity.

**Transference to treatment card**

The pretreatment cephalometric tracing is placed on an X-ray viewing box with the treatment envelope or card orientated appropriately on top, that is, with FH parallel with the top of the envelope. The lights are switched out, and the tracing traced onto the treatment card or envelope in black ballpoint, since it is waterproof — essential in a surgery environment. Subsequently, when the final objective for the teeth has been determined according to the steps given below, the objective is traced in red ballpoint pen.

However, there is one important point which needs to be mentioned before proceeding. The purpose of the following VTO is to relate the maxilla to the mandible only, since this is mostly our area of influence. That is, cranial base etc will be disregarded for non-surgical cases. The important point is —

If normal growth is to be realised, then the mandible needs to project away from the maxilla else the reverse of the maxilla being retropositioned away from the mandible will pre-age the face especially in forward rotators.

This concept conflicts with the VTO suggested by Magnes (1987). The rationale for this author's view is that, in tracing hundreds of cases post-treatment, he has seen only one case where the lower incisors do NOT distalise relative to the symphysis within five years of treatment, and not one go forward. As well, in that minority of cases where the maxilla rotates forward in Begg cases, the mandible usually rotates forward.

**Steps in creating a VTO**

1. From your past experience of tracing post-treatment cephalograms of similar cases, forecast (or budget) where Pogonion or Superpogonion will be when growth is completed relative to the maxilla. Otherwise, use the following cookbook approach initially. However, even here it is prudent to acquire someone else's treated case records, if possible.
   (a) Look at the Hand and Wrist maturity indicators to guesstimate how much growth is left.
   (b) Take away the amount the maxilla will also grow. This will give an estimate of how much Pogonion will grow in relation to the maxilla. Use Dr Lysle Johnston's template as a guide.
   (c) Guesstimate the direction the mandible will grow in relation to the maxilla, using the usual indicators (see example under 'Considering all factors or variables' in Expert System rules in Editor's newsletter).

2. In general, the brachyfacial types will grow forward and the dolichofacial ones backwards.

3. Place a red dot where the estimated position is for the new Pogonion.

4. Draw in the new A-Pog line (Figures 10 and 11.)

   - Place the treatment envelope over the tracing which in turn is placed over the tracing light.
   - In the vertical dimension, apply the principles from that text earlier and captions related to Figures 1 and 2.
Lightly draw a pencil line at where the incisal edge of I will be.
5. Slide the envelope forwards or backwards over the original tracing to apply the following rule —
   Variables related to antero-posterior positioning of the lower incisor are: Its relation to the NEW A-Pog line, lip incompetence, naso-labial angle, lip thickness, ability to retain adequately.

   In general, the lower incisor should not be moved further away from the new A-Pog line (Figure 12). If the lips are incompetent and there is little growth left, then one would consider some retraction of the incisors to allow lip closure (Figure 14).

6. Trace the lower incisor in red onto the treatment envelope in its new position. For the first few VTOs it would be prudent to do this in pencil so that it may be erased if the position is found wrong from further contemplation.

7. Adjust the envelope over the original tracing according to the following rule, and trace I in red onto the envelope —

   When the temporary pencil lines are erased, the clinician will have:
   A visible visualised treatment objective (VVTO)
   It is not only an advantage to have a detailed position of the teeth to aim for in graphic form, but (Mollenhauer, 1984b): If the V.T.O. is readily available on the treatment card, then it is available for easy reference for treatment procedures such as bending the degree of severity of the anchorage curves for each archwire.
   A finishing cephalogram is taken towards the end of Stage III. Exceptions are when there is a particular concern, such as anchorage loss or the lower anterior apices requiring considerable torquing forward, to justify taking one halfway through Stage III. In general, as the
name implies, a prefinishing tracing is done before finishing archwires are placed. The pre-finishing tracing is transferred to the treatment envelope in green (Figure 15).

Similarly, a pre-discharge tracing is done before the lower fixed retainer is removed to check on the position of the anterior teeth and possibly the third molars. Usually this is some three years after debanding, but is naturally dependent on the third molar situation. It is transferred to the treatment envelope in blue. These follow-up tracings also allow one to monitor such features as eruption of the third molars and root resorption.

An advantage of the concepts of prefinishing and predischarge tracings is that, because they must be traced and analysed before the next step is taken (e.g. applying finishing archwires), the tracing is a valuable self teaching tool.

As well as the VVTO resulting from the lateral cephalogram one can also determine the arch form from the study models, and transfer this to the treatment card. This saves considerable time by not having to determine the arch form for each visit. It also overcomes the problem of reforming an archwire or forming a new archwire — arch coordination can be achieved without having to remove the other archwire. It is particularly advantageous when crossbites were part of the original condition. Furthermore:

If the arch form is documented, then it is a valuable self teaching tool.

For example, one soon learns that frail dolichofacial prepubertal females will tolerate less arch compensatory expansion than a strongly built older male, in Stage I. In Stage III all practitioners new to the technique should record the archform, and even established practitioners will find it an advantage whenever a new mechanism or wire is tried.

Transference to the treatment card

The documented archform is created (Mollenhauer, 1983e) by placing a small piece of acetate tracing paper over a clear plastic sheet, or piece of glass, which is held over the lower study model. Pencil marks are made on the acetate paper one millimeter from the vestibular surface of each tooth, that is, where the archwire would engage the bracket. This part may be done by the dental nurse. The dots are checked by the orthodontist, and then the paper is folded down the midline. One side of the archform is drawn and then the paper is turned over and this curve is copied for the other side. This ensures symmetry which applies to the heavier wires — only light arch wires are formed asymmetrically as required for overmovement. The upper archform is drawn outside the lower archform, using White's (1982) findings as a guide, with allowance only made for crossbite overmovement.

These archforms are transferred to the treatment card or envelope in the time honoured method used by school children. That is, the tracing paper is turned over and the archform is transferred to the card by rubbing a pencil over the smooth top surface. It is prudent to finalise archform in lead pencils so that it may be erased and redone if circumstances later necessitate a change.

Clinical assessment aided by study models

A critical question which must be addressed in the Begg world relates to overmovement and contemporary views on functional occlusion. To some degree this depends on the veracity of the current cuspid protected/incisal guidance concept. Even if the theory of disclusion applies to only certain types of patients, as suggested by Di Pietro (1977), traditional Begg teaching of an edge to edge relationship in all cases must be modified.

The axiom that Begg practitioners could consider in more depth therefore is “all dental and occlusal abnormalities should be overmoved”. This means that excessive overbites should be reduced to an edge to edge relationship or even a mild open bite, while conversely, an open bite case should be corrected to an excessive overbite situation. Therefore, a natural question is, in between these two extremes, what type of overbite status should be left as found? In other words, what is the eventual degree of anterior disclusion after settling to be aimed for, as part of Begg treatment. In point of fact, the author submits that the following rule has been rather neglected in the teaching of the technique:

Beware of the lack of creation of incisal guidance or sufficient overbite in cases which originally had insufficient overbite, including the overbite of the cuspids (cuspid protection).

This is a quite a difficult question to pose, and it should be given considerable thought before the next question about the functional occlusion in the buccal segments posed a little later. It would be of great benefit to have Di Pietro's work supported by another study, with larger numbers. Intuitively, Di Pietro's results certainly fit in with observations of different racial types. For example, during the Australian Orthodontic Congress in Hong Kong, one had the opportunity to see many people with a “group function” type of occlusion and there is no reason to suspect that they have a higher incidence of TMJ problems.

Nevertheless, as well as creating a positive overbite for discussion, it is prudent to strive for overmovement to compensate for late adolescent vertical growth in these dolichofacial types. Failure to do so can occasionally result in insufficient overbite to maintain the alignment of upper anteriors, especially the smaller lateral incisors which may slip back into a crossbite.

One needs not only to consider the anterior disclusion, but also the buccal disclusion. It is this latter area where there is probably more agreement, namely, that non working side or balancing side prematurities are a potential source of dysfunctional problems.

If one is unable to achieve full and stable cuspid protected occlusion, then the more one should attempt to torque the roots of the upper buccal teeth buccally to reduce the prominence of the palatal cusps of these teeth for non-working side interference in lateral excursions.

The key word here is 'stable'. That is, a reasonable initial thought would be that prefinishing study models should be routinely mounted on an adjustable articulator for all dolichofacial patients. But the true test would come some years after treatment when vertical growth has been expressed.

Thus the second functional question is: If the Begg axiom states that all dental malpositions should be overmoved, then why are the roots of 17, 16, 26 and 27 not overmoved buccally?

Furthermore:

If one has not had the opportunity to correct a unilateral posterior crossbite in the mixed dentition with a fixed palatal expander then, for these cases, Begg mechanics should include flat oval tubes on the upper molars from the outset.

Achieving the treatment aim

The worst aspect of traditional Begg dogma is that exemplified by the statement ‘The Begg technique achieves superior results.’ Surely it is a case of having a good treatment objective and having the mastery of the appliance to achieve that objective rather than just let “something” happen. Mastery of the appliance takes many years of objective self criticism. Objectivity is achieved by documentation such as serial cephalometrics and study models.

TOOTH REDUCTION

The decision to extract, strip or not is made quite obvious when the information from the VTO and archform objective is available.
Consider the Figures 10 and 11.

**Variables related to non-extraction cases are:** growing brachyfacial types, need for heavy anchorage curves, minimal crowding or spacing, obtuse nasolabial angle, buccal crossbite expansion, apices of anterior too far distally placed, soft and competent lips.

**Variables related to extraction cases are:** moderate to severe crowding, dolichofacial cases treated during the parapubertal years by continuous force appliances, apices of anterior too far forward, little overbite, incompetent lips, so called mentalis habit (also known as expressive behaviour).

If both cases in Figures 10 and 11 had minimal crowding, then Figure 10 could be a non-extraction case. On the other hand, Figure 11 could be an extraction case, and even on occasion a six extraction case.

So the old rule of thumb '4 x 4 — if not, why not' is quite invalid in the 1980s.

### BRACKET & TUBE POSITIONING

Common experience with the Begg technique, and initiated by Dr Begg himself, is that treatment proceeds far more smoothly and efficiently if attachments are placed securely to endure without replacement throughout treatment. This will be covered in the next section.

As well, the practice of using finishing archwires routinely confirms the need for the correct placement of brackets and tubes from the outset. That is, rather than place offsets in the finishing archwires to complete alignment and leveling in the last few months, stability is better ensured by having tooth/tooth relationships correct throughout most of the treatment.

**Offsetting brackets.**

Of considerable help in this regard is the offsetting of brackets for rotation and occasionally for alignment (Mollenhauer, 1983d).

* If brackets are offset, then exactly the same offsets do not have to be placed in each archwire — which reduces discomfort to the patient and chairside time for the clinician*.

Dr Begg recommended offsetting brackets on the cuspids and premolars, and the procedure can also be implemented on bonded anterior brackets (Figure 16).

* If ligature wire is spot welded to one proximal edge of the bracket base, then this edge will stand out further from the tooth surface which in turn will produce an inward force by the archwire.

This rule applies to rotations, but offsets on both sides will in-staand the whole crown. The thickness of the ligature wire will depend on future requirements. Since the author routinely uses thick finishing archwires, 012" ligature wire is used for offsetting the bracket bases. In practice, the edges of the bases to be offset are marked on the lingual surfaces of the study models (Figure 16(b)) and the nurses weld the ligature wire in the appropriate places before the patient arrives for the banding appointment. The marking takes several seconds of the orthodontist's spare time and no chairside time.

![Figure 16(b): Diagrammatic representation of a bonding base to which has been tack welded a piece of -012" ligature on one side. This raises the bracket on this side, resulting in a rotational effect on the tooth with a plain archwire.](image)

![Figure 17. Use of an impregnated rubber wheel to remove the last layer of bonding composite from the enamel without producing score marks. Note the smoothness of the 21 surface. It may also be used to smooth rough enamel, perikymata, and the score marks from stones and burs which have been used to trim teeth. Heat production must be minimised, such as by an air spray (see nozzle at top left). It may also be used to smooth the beaks of pliers used to handle extremely high tensile wires.](image)
Interaction of the Teeth
Not infrequently the teeth require trimming, or an enameplasty, to change their anatomy.
Following trimming, it is prudent to smooth the surfaces with an impregnated rubber wheel such as that used for debonding (Figure 17). This compares with teeth which have been trimmed by a bur and not smoothed in this manner. They often show score marks when shown on a lecture screen.

* If brackets are to be placed on the incisors, then the incisal edges should be trimmed and smoothed beforehand to provide a base for measurement of bracket height.

The key word is 'beforehand' (Mollenhauer, 1983). The advantage of this is that the teeth are levelled in the early stages of treatment and maintained thereafter to stabilise them. Trimming afterwards, as in the so called 'manicuring' procedure, can occasionally pose unexpected problems.

Furthermore, smoothing all the enamel surface seems to be a valid preventive periodontics measure by flattening the perikymate near the gingival margins, especially below the brackets. That is, oral hygiene is easier throughout treatment and beyond.

Reshaping cuspids to simulate missing laterals incisors is done similarly, except that it should be done over several months, such as when the cusps are erupting into occlusion.

Some trimming must be put off by circumstances, such as trimming asymmetrical lingual margins on upper incisors, because crowding may make access impossible. This particular trimming is essential for lower incisor stability after treatment, as well as possible TMJ considerations (Slavicek, as reported by Kulmer 1985). Abnormal lingual anatomy is less frequently noted now that upper incisors are bonded rather than banded.

Heights of brackets
- If one wishes to use ribbon finishing arches, then the brackets must be correctly placed vertically for levelling in the early stages, so as not to make the teeth sore when the heavier wires are used.

Two schools of thought still pervade the Begg world regarding the actual height of brackets. Some still prefer to place the brackets near the incisal edge while others follow the usual orthodontic position near the centre of the crown. Whichever is preferred, the important feature is that the brackets are related to the adjacent teeth for correct levelling (Figure 18).

Traditionally, Begg bracket positioning has aimed towards group function. Whilst this may be suitable for the early stages of treatment much of the dental world favours cuspid protected occlusion and incisal disclusion. In brachyfacial cases, the overbite tends to relapse to provide disclusion by the anteriors, so these cases are generally self correcting in retention.

Bonding
- If Begg brackets are used with small bonding bases, as is usually the case with non-combination brackets, then the clinician should maximise the advantages and minimise the disadvantages of small bases.

As well as the aesthetic advantages of small bases, there is the advantage that the base and therefore the composite line may be kept away from the gingival margin so as not to cause irritation. A small base allows a smaller area to be etched and thus the acid may also be kept away from the gingivae. Since acid irritates the gingivae, gingival seepage is minimised if the etched area is contained.

Smaller bases also allow easier removal of excess composite which has been shown to attract plaque, even microfilled composites, and cause incipient caries (Artun and Thylstrup, 1986) and periodontal problems (Zachrisson, 1985). The excess composite may be controlled in the following way. Whilst the composite should be wet enough to achieve adhesion, it should be sufficiently gel-like for the excess to ball up at the margins. This allows the excess to be removed with a plastic instrument (Figure 19). Occasionally, the composite dries out with repeated opening of the top of the bottles. For this problem, a small amount of unfilled resin should be added to the respective bottles.

Yet another advantage of small bases is that the edges of the base may be kept away from the gingivae for more effective oral hygiene. Plaque control for periodontal reasons is especially important in the Begg technique because of its efficacy for intrusion. That is, plaque should not be carried deep into the tissues with intrusive tooth movements.

On the other hand small bases provide less area for adhesion, therefore the techniques for bonding in the Begg technique should optimise the strength and adhesion of the strongest available composites, which are generally the heavily filled microfilled variants.

* Variables related to bonding are: 1. adequate etching 2. Oil contamination 3. salivary contamination 4. gingival seepage 5. weftiness and wettable of the composite/enamel interface 6. movement during setting 7. physical disturbance of etched enamel 8. constant pressure until set particularly for heavily filled composites.

Gingival seepage cannot be studied in the laboratory but is obviously a most important variable. It may be controlled by a simple routine in practice.

* Differentiate between the separation appointment which still have gingivitis and those which do not, so that the former may be put on a regime of cleaning with sodium bicarbonate to reduce gingival seepage during bonding and banding (assuming that treatment cannot be delayed).

In a Clinical Aids section, Cannon (1986) pointed out the advantage of using a dentrifice with sodium bicarbonate. Although Newbrun et al (1984) have shown that certain microorganisms are effected by this chemical when exposed over a 30 minute period, that is not acceptable clinically because of gingival burning. So the effects of the above regime are to dry out hypertrophic gingivae. Oral hygiene regimes to treat established gingivitis may take months to have their effect. Therefore, to reduce the gingival seepage during bonding and banding such regimes should be started as long as possible before the appliance is placed. Seepage is a particular problem with small instanding lateral incisors where there is poor oral hygiene.

The 8th variable listed above refers to the need to hold the bracket on the tooth under pressure until the initial set, when using filled composites. This conclusion results from clinical experimentation by the author using Silar and Gillys (1986) noted that particles are required to provide shear strength to reduce fracture at the mesh/composite interface, but heavily filled composites exhibit a 'rebound' phenomenon if not held against the enamel until set. This information was added to the knowledge that, in laboratory experiments, traditionally a weight is placed on the specimen until the material has set. Such a situation does not simulate clinical practice where the tooth surface is rarely horizontal. It was decided to simulate the laboratory procedure in clinical practice at least in terms of applying a heavy force to the bracket until the composite had set. This had two interesting sequelae. Firstly, the number of loose brackets reduced dramatically. Secondly, the author had disband a former practice of applying fluoride immediately after bonding to exploit the high surface energy of the etched enamel not covered by the bracket base, because many brackets fell off — sometimes minutes later. When the brackets are held down firmly (see the blanched fingers in Figure 19) the
adhesive strength remained high even when topical fluoride is applied immediately after bonding.

Two major factors may be combined within the one technique, whereby the operator holds the brackets down firmly with a serrated band pushing instrument until the material has set, while the nurse wipes away the excess with a plastic instrument. Note that the plastic instrument has had the end ground flat and square. The consistency of the paste, determined by the amount of resin added, is critical for controlling the wetting of the enamel adjacent to the base.

However, one group of teeth let us down in the campaign to eradicate loose brackets entirely from the practice: these were the hypoplastic teeth —

*Variables related to bonding to hypoplastic enamel are: 1. The white flecks are removed by the etching process — this presents a cosmetic problem after debonding. 2. Hypoplastic enamel requires more 'wetting' for bonding. 3. The enamel is often soft — which should be born in mind when trimming away composite remnants, trimming the tooth anatomy and stripping.

Barkmeier et al (1987) stress the importance of good wetting for bonding. When unfilled resin is applied to wet the hypoplastic enamel, which is a necessary practice to reduce loose bonds for these particular teeth, then only a small amount (pinhead size or less) should be placed because it spreads considerably. This conforms to the important principle that excess resin should not be left around the base. If the unfilled resin does spread too far, then the excess should be removed with a prophylactic brush immediately the bond strength is sufficient.

Too many Begg orthodontists are besotted by the hypothesis that bonded brackets should be easy to remove. All that is required is a good debonding technique. Begg brackets are easy to 'pop' off by squeezing with ligature cutters, compared to edgewise brackets. The remnants may be removed with an impregnated rubber wheel (Figure 17) which must be cooled with air to prevent excessive heating of the tooth.

**BANDING**

- Variables related to satisfactory banding are: 1. correct size of band, 2. correct position of band vertically and rotationally, 3. sufficient grip of the undercuts, 4. band and bracket/tube free of occlusal trauma, 5. appropriately strong luting agent handled correctly and preferably with fluoride release.

The correct sizing of the bands is related to the competence of one's separation system. Those who saw Dr Begg band a case will remember that the bands themselves were the separators over a 24 hour period. And he always tightened them most fastidiously at the next appointment before cementation.

His standard for band fitting was always the same — a band would not be cemented until its retention on the tooth was so tight that it was difficult to remove with the fingers alone, for cleaning and cementation. This important feature of his own treatment has never received the emphasis it deserves, hence the following rule -

- If the band is easy to remove with finger pressure, then keep shimming until it is finger tight.

However, if the band requires more than three shims, then it probably was the wrong size in the first place. Medium metallic gauze, as used for denture strengthening, is very good for slimming the lingual of molar bands.

Dr Begg advocated offsetting the bands and brackets on premolars and cuspids. However, if the upper premolars are not rotated, then the brackets should be offset mesially, according to Zachrisson's comments at the Sydney ASO Congress. However, such a position is dependent on one's practice with finishing archwires.

- If finishing archwires are not used routinely, then that practitioner should carefully evaluate his finished cases to decide upon using anti-rotation offsets.

Roth and Hocevar both use anti-rotation techniques. In the Begg technique, the uprighting springs may produce a rotation effect and this should be looked for by each practitioner, and counteracted if required.

Finally, for bonding, there are the important variables of the choice and the handling of the cement.

- If buccal teeth are banded, including the lower cuspids, then there is no reason not to use a glass ionomer cement.

Fricker and McLaughlin (1987) have shown a considerable reduction in loose bands using glass ionomer cements. The author has used this material for a longer period with the opportunity to take the matter further. For orthodontic luting, the powder:liquid ratio may be increased significantly which yields a much greater strength. Christensen (1987) has confirmed this in laboratory experiments with 30% more powder. However, the author has found that the ratio may be 50% more powder than the manufacturer's recommendation for Ketac? when the liquid and powder are kept in the refrigerator until the time for mixing. Some authorities disagree with keeping the powder in the refrigerator due to possible solidification, but generally orthodontists use their luting stocks quickly. The glass ionomer cement may be left in the fissures during clean up to act as a fissure sealant with fluoride releasing properties (McKenna and Grundy, 1987).

Chilled thick Ketac Cem is ideal for the cementation of a lower fixed retainer, because the heat from the mouth accelerates the set once it has been seated — especially for those odd occasions when the appliance needs to be held in place until the cement has set.

- If a clinician follows the trend back to banding the lower incisors, then glass ionomer cements should not be used on these teeth, as their strength is too great in this segment.

In fact, silico-phosphate cements, which have a fluoride release similar to glass ionomer cements, are quite satisfactory for the lower incisors. Both cements provide optimum properties if isolated until set, such as with (Dry)foil. The excess cement is removed with cotton rolls before the foil is placed, particularly for the glass ionomer cement, because of the difficulty of cleaning up the set cement.

In summary —

- If the bonds or bands do not come loose during treatment, then the clinician can concentrate on treatment progress and the associated cooperation.

Loose brackets may also predispose to decalcification. Therefore the aim should be for 0% loose attachments. That is, the degree of retention of the appliance should be a state of overkill, which is what Dr Begg did in his practice. Thus no apology is made for the degree of detail discussed in these sections on bonding and banding.

**ARCH WIRES**

Two important rules are as follows.

- Differentiate between tooth moving wires (forces) and other wires.

Tooth moving archwires include aligning archwires, rotation springs, torqueing springs and uprighting springs. Other arches include base arch wires for Stage III, palatal arches and other molar control mechanisms particularly for molar torque. The trend now is to use ultralight wires for tooth movement which may be contrasted with the base archwire which should be substantial to resist arch form distortion.

11 Espe, D-8031, Suedi/Obabay, West Germany.
A group of pliers which are invaluable for handling thicker high tensile wires is that which will bend curves in wires. Two levels are desirable. One should have a gentle curve and the other a tighter curve but both should have the beaks polished with the impregnated rubber wheel. The former is generally used for placing anchorage curves and aiding in arch forming, outside the mouth. The other pliers are useful for Bypass archwires (Figure 20) and temporary replacement of anchorage curves, as intraoral adjustments.

▶ Beware of indelicate and unmonitored use of intraoral adjustments as they are fraught with undesirable consequences.

Aligning archwires
Most orthodontic cases require some alignment, therefore a competent, comprehensive and non-iatrogenic system should be mastered (Figures 21-24).

▶ If auxiliary aligning archwires are to be used, then:
  1. The main archwires are preferably attached piggy back so that the aligning archwires have the freedom to align the teeth.
  2. In general, it is more practical to restrict aligning arches to the six anteriors.

A major advantage is —
* If ultralight aligning archwires are used, then alignment can be accomplished concomitantly with intrusion and overjet reduction by the main archwire (Figure 24).

Furthermore —
* If ultralight auxiliaries are used, then less distortion of the archform occurs.

The latter applies if cantilever auxiliaries are used to bring cuspsids out of the palate, especially if the main archwire is made from .018" high tensile wire or heavier.
So the advantage of these last two rules can be summed up in another rule —

If the treatment is smoother and quicker from appropriate aligning mechanics, then more time is available for finishing mechanics.

Naturally a rider for efficient alignment mechanics by fine high tensile aligning auxiliaries is —

If this early part of the treatment is less painful to the patient and causes less gingivitis, then it engenders confidence in the treatment.

But with all these advantages there must be at least one disadvantage. This disadvantage is that, since the teeth move so quickly, tucked-in ends of the segmental arch often twist out to produce irritations within days of initial application. Therefore it is necessary to control the ends. This may be achieved by forming boxes to encompass the brackets of the distal-most teeth, usually the cuspids. This is shown in Figures 21-24 and it may be pointed out that since the wire is so fine, it does not exert a bodily effect on the cuspids and so, in practice, does not contradict the principle of tipping movement in Stage I. The real test of this is that it does not inhibit overjet reduction. Another specific feature related to this wire is —

If very fine wires are used, then large overbends must be incorporated to over-align the teeth.

This overmovement is one advantage over twisted wires for alignment, along with less friction and cost. The author has found the .009” Supreme wire to be the best compromise. For very rotated and malaligned upper anteriors, .008” wire has some advantages.

If one tooth is very rotated and the rest are well aligned, then a rotation spring of the type suggested by Dr Paul Lee is appropriate.

This is preferably made up in .012” Premium Plus wire which obviates the need for a coil and is inserted into the rotated tooth bracket which is ligated to the archwire. The end bent out for activation is pinned into the bracket of the adjacent tooth (Figure 25). This does away with the need for a hook which takes time to bend and which occasionally causes irritations.

“Bypass” archwires

Dougherty (1987) has pointed out the variations in these archwires from the 1920s to the present utility arches. To this could be added that archwire developed by Dr Alastair Merrick of Sydney. The following is another development which has the prime purpose of a configuration to prevent distortion. It followed from a local ‘think tank’ of material scientists chaired by the author, which attempted to find a material which would withstand occlusal distortion. The conclusion from this meeting was that a material was not currently available to meet such a specification. Thus changes to the format or configuration of the archwire was the present answer.

If the lower archwire closely follows the contour of the alveolus, then moderate distortions would press the wire into the mucosa providing a self limiting situation.

Experiences from Edgewise colleagues indicated that utility arches did distort if the bend down in front of the molar was not placed adjacent to the molar tube. Therefore, a sliding utility type arch would not meet the requirement. Thus a Merrick-type format held more promise, because the sides pass low below the molar tube and it could be used as a non-stopped arch. As a result of cephalometric and clinical development, several features of the author’s Bypass archwire (Figure 26) may be reported:

1. To reduce mandibular rotation, the anchorage curve should be incorporated in the body of the archwire rather than the return through the back of the tube.

2. The molars roll in quite readily, therefore a heavier wire than .016” is required for molar control. Naturally, with the return as part of the archwire, these archwires are longer than normal archwires before the molar tube is engaged. A .018” Premium Plus is suitable, which is heavier than the early Merrick arches of .014” wire.
3. Whilst the vertical forces should be enough to provide sufficient force for anterior intrusion and molar anchorage, it should not be excessive otherwise molar elevation occurs.

4. The worst feature is the insertion of the archwire, due to the discomfort which may occur during insertion into the second tube, especially in younger patients.

5. Whilst distortion on insertion is minimised by the used of the highest tensile wire, the archwire usually needs some re-activation after placement — this may be accomplished by very careful activation with Tweed loop forming pliers (Figure 20). The emphasis must be on the word 'careful' to prevent archform distortion and overactivation. Archform distortion will occur if the bend is other than purely vertical.

This procedure can also be a source of discomfort when the anterior part of the archwire is let free to evaluate the activation. However, this can apply checking normal arches.

Apart from the advantage of virtually eliminating distortion and thus being able to produce remarkable amounts of intrusion, it has a particular bonus for non-extraction cases —

- If a lower arch length increase is required or the lower anterior require proclination, then the Bypass arch can be cinched back against the mesial of the molar tube for expansion.

This provides good separation for banding the premolars (Figure 26(a)). It is prudent to monitor such cases cephalometrically, but with some delicacy, the roots of the anteriors are not pivoted back. The author would like to compare this with a recently advocated practice of placing udder arches on the lower anteriors to throw them forward.

This reverse-cinching process can also be used for those occasionally stubborn brachyfacial cases where it is extremely difficult to reduce a Class II relationship of the cuspids. Bypass arches may also be used on the upper arch in mixed dentition treatment for anterior crossbites (Figure 27).

**Anchorage curves**

Many Australian orthodontists have changed to anchorage curves as advocated by Dr Begg, rather than placing anchorage bends. These are particularly useful on the upper arch because —

- If severe anchorage curves are used on the upper arch with .018" Premium plus wire for upper anterior intrusion, then anchorage curves cause less tipping back of the upper molars than anchorage bends.

Such a situation is most likely to be suitable for a Class II Division 2 type of case where maximum intrusion of anteriors is required. Conversely, in a dolichofacial type where the VTO indicates that the case should be treated non-extraction or with the extraction of lower second premolars, one is able to pin the archwire into the lower first premolar brackets from the outset. Then the following rule may apply (Mollenhauer, 1983a) —

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Figure 22. Note the large amount of offsets placed in the .009" auxiliary aligning archwires, and the main archwires piggy-back over the incisors.

Figure 23. Another example of ultra-light aligning auxiliary archwires in .009" very high tensile wires. Despite the rapid tooth movements, note the good gingival health which is typical of these ultra-light aligning arches.

Figure 24(a). An example of the concomitant GENTLE alignment of the anterior teeth, in this case bringing a cuspid out of the palate, while overjet and overbite reduction proceeds normally.

Figure 24(b). Note movement of 23 with .011" Premium Plus cantilever arch in 3 months.

Figure 24(c). Original overjet of this case with the deciduous cuspid still present on the study models.

Figure 24(d). Note the reduction of the overjet also during the 5 months. At this point the end of the cantilever auxiliary was re-adjusted incisally to extrude the cuspid, since it has passed out of coincidence with the lowers.
Simple torqueing mechanisms

Dr John Jenner, of Adelaide, presented a simple type of torqueing arch at a Begg Study meeting some years ago which has found a niche in the author's armamentarium. It works best if it has a long span, rather than for two adjacent teeth, and if activated correctly (Figure 4). It has application in the following 'Exception to the rule' rule—

If one is in Stage I mechanics, then torqueing forces should be avoided.

But an exception is when the roots of the upper cuspids are disconcertingly prominent.

Although the particular indication for this mechanism is not common, it is surprising how the overjet reduction actually speeds up. Usually it is only required for a few months, which is fortunate because of the adverse effect on the archform.

'Mousetrap' torque and 'U' spring

About the time the author received a personal transfer patient from Dr Begg, he had been looking for a mousetrap torqueing mechanism which did not distort the main arch or the torqueing arch during insertion. Dr Begg's patient had an incisally activated mousetrap which met these requirements. It has the added bonus of better oral hygiene above the brackets. The presently available -0.11" Premium Plus wire makes this even more desirable (Figure 29). This wire has been found to be a nice compromise for flexibility, robustness and gentle enough application.

The last attribute is due to the fact that the wire winds up and over the main archwire to its point of application, compared to the gingivally applied type wherein some have found -0.09" wire to be suitable. Gentle torqueing forces are recommended by Reitan (1985).

If one intends to use a mousetrap mechanism then the Stage II/III archwire can be fabricated in -0.022" Special Plus with the midline spur already included.

The advantage of this system is that the heavy Stage II/Stage III base archwire can be gradually engaged over a number of visits in Stage II to reduce harsh forces in one visit.

The mousetrap can be partially prepared beforehand with a good width to the bar which will sit against the midline spur of the main base wire. Following removal of the main archwire when the case is ready for Stage III, the bar is held with pliers against the spur and the mousetrap wrapped on. The advantage of the mousetrap torqueing auxiliary is that the teeth may be torqued individually.

Oddly, Class III torque, or labial root torque, requires more force, even on the lateral incisors.

The incisally activated mousetrap is held down with a 'U'spring made of -0.14 or -0.16" wire (Figure 29). This equalises the torque effects on the two upper centrals and allows artistic finishing via controlled uprighting.

A "full" mousetrap mechanism which extends to the molars (Figure 5) is discussed under molar torque.

If one routinely does prefinishing cephalometric tracings, then the frequent need for labial root torque of the lower incisors becomes obvious.

This has traditionally been attempted by Udder arches which are so named because their activated shape out of the mouth looks somewhat like a cow's udder. The problem has been that the commercially available ones are either made from wire with insufficient resiliency and they are not activated enough; or in another brand, the wire is -0.016" which causes excessive molar flaring especially when it engages near the molars. Wilcock's -0.014" Premium Plus in extreme activation remains the most effective form from cephalometric evaluation (Mollenhauer,
Reitan (1985) recommended that 'the fixed appliances be left on the teeth for at least two months.' This is confirmed by clinical observation. Use of finishing archwires and rigid retention cushions the problem of "tissue shock." Initially, the author used \(0.019 \times 0.019\) Elgiloy\textsuperscript{+} wire for some years as a finishing wire for tidying up and coordinating archforms, whilst holding the torque which had been achieved during Stage III. This size wire is still used with some transfer cases with smaller bracket slots. However, it was found that more control could be achieved by forcing an \(0.016 \times 0.022\) \textsuperscript{+} wire into the base of the slot in an edgewise mode. They could be held there with T-pins\textsuperscript{+} to give a three dimensional control, or uprighting springs could be continued if a few teeth required a little more uprighting. This size wire can only be inserted into some bracket slots in this way, such as the Unipoint brackets\textsuperscript{+} used by the author. The edgewise mode allows gentle levelling of the teeth if this is required, because it is the \(0.016\) dimension which is active in the vertical dimension. Another advantage of the edgewise mode is that boot hooks or bull loops can be incorporated for space closure. To sum up:

- If vertical movements and/or space closure are required to finish the case, then finishing archwires should be applied in the edgewise mode.

The heads of the T-pins\textsuperscript{+} which are used to hold the uprighting movements, suffice for attaching the elastics.

Each clinician will need to experiment with various wire dimensions to suit his/her brackets. However, one should beware of some brands of rectangular or square wires which do not have sharp enough corners to engage the slot adequately — despite their nomenclature. A very important vertical movement can be the sinking of the premolars into tight interdigitation to reduce dramatically the incidence of relapse of Class II malocclusions. Such a manoeuvre may be done by introral adjustment at the appointment before debanding if time is short.

- If an open bite, in particular, requires closure in the finishing stage, then less vertical resistance to the anterior box elastics will be achieved by using \(0.016 \times 0.022\) twisted wires\textsuperscript{**} in edgewise mode.

It is prudent to solder the ends of twisted wires (Figure 30) to prevent irritations and to facilitate clinching. These twisted wires are also useful when the lower molars are grossly malaligned (Figure 31), such as frequently happens in the case of poor elastics wearing when the

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priority has been to reduce an excessive overbite. The second molars are banded for this procedure. Rotated second molars, however, should be corrected early in Stage III by a mechanism such as that suggested by Jenner (1984) to allow an adequate length to time to stabilise them.

- If particular care is taken with the heights of brackets during bonding and banding, then a heavy rectangular may be used in ribbon arch mode to torque the roots of the buccal teeth.

It must be emphasised that the commonest reason for not using such finishing techniques is the worry of dislodging brackets, particularly when the last T-pin† is being tightened! — hence the need for a strong bracket adhesive.

Again, experimentation is necessary for the ribbon arch size for each bracket type. 0.019 x 0.026" works well in the author's brackets, but thinner slots may require 0.018 x 0.025" wire to allow easier insertion. Molar torque is discussed shortly.

- If heavy rectangular arches are used, then they should be of the softest variety and rarely heat treated, and never heat treated for the initial application.

Heat treatment is particularly useful in Class III cases wherein one often wishes to torque the roots of all upper teeth out labially and buccally. But the archwire should only be heat treated after a month of full engagement.

Even for non Class III cases, there can be advantages in being able to torque the roots of cuspids. An earlier rule stated that one should differentiate between the positions of the cuspids spicis depending on the stage. For active movement, the roots should be well in the cancellous bone. However, in the finishing stage their roots may and should be placed against the cortical bone.

During finishing mechanics it is preferable that elastics wearing is ceased to assess stability and to check the CR/CO coincidence. An exception would be anterior vertical elastics for overbite correction.

- If the clinician is experienced in applying heavy rectangular arches in ribbon mode, then this expertise may be applied to orthognathic surgery cases.

This last rule would lay to rest one of the most common criticisms of the Begg technique. Not infrequently, premolar torque is required. Thompson (1985) rightly lists this omission in the disadvantages of the traditional Begg technique.

UPPER MOLAR ROTATION AND TORQUE

These are such important aspects to new approaches to the Begg technique that they deserve a section on their own, despite the fact that they are not a routine problem, especially if the anchorage curve is replaced with a toe-in curve in the Stage III base archwire.

Finishing archwires allow one to tidy up the rotation of the upper molars according to the type of malocclusion (Zachrisson, 1986).

- If the case is a Class II or has large upper anterior teeth, then the upper molars should be excessively rotated with the buccal surface distally.

Conversely, Class III cases or ones with small upper laterals should have the upper molars rotated with the buccal surfaces mesially to increase their mesio-distal dimension.

The lack of molar torque is one of the common criticisms of Begg teaching, although one could always make up a torquing mechanism if required. The type shown in Figure 32 had two important drawbacks although it was quite effective. One problem was that only one side could be done at a time, which was adequate for the illustrated case where the first molar on the side of the crossbite correction required torque. The second problem was the relapse as seen in the study models.
brands of upper molar tubes which are not offset from the band material at the distal to provide access for this tube cinching procedure. Only if this has not started to work within two months, should heat treating be considered, such as in wires less than "019 x 026" in size.

The drawback of this molar torquing procedure is that molar torque is being achieved in the finishing stage and so the treatment time will be increased.

When the molar roots are torqued buccally, a reciprocal torque, similar to the usual torque of the anteriors in Class II cases, is applied. This should be born in mind when placing the torque in the anterior aspect of the upper rectangular finishing archwire when the above procedure for molar torque is to be used. As an aside, lower rectangular finishing archwires require no lingual root torque. But, if they are heat treated for any reason, monitor the case carefully for gingival recession.

As mentioned on two previous occasions, the torque of the upper molars should be carried out in Stage III. This can be achieved by the extension of the mesetrap to a "full" mesetrap to include the molars. (Figure 5). The free ends of the mesetrap are placed in the occlusal of twin tubes which the author has included for about twenty years to carry very back arches to tuck in buccally placed upper second molars.

Advantages of 'full' mesetrap mechanism
1. Molar torque is reciprocal to anterior torque.
2. The cusps may also be torqued to place the apices into the alveolar trough for more efficient uprighting with the uprighting springs.
3. Molar torque is achieved earlier (Stage III) for greater stability, rather than as a final activity in the finishing stage.

Disadvantages of 'full' mesetrap mechanism
1. It is time consuming to bend accurately for easy placement.
2. It is extremely difficult to bend for non-extraction cases.
3. It does not extend to the second molars.

The second disadvantage is a pity, because the need for molar buccal root torque, which also seems to aid anchorage as one would expect, is especially desirable in non-extraction treatment.

Another alternative would be ribbon arch tubes of dimensions "022 x 030" as a routine Begg tube. As well as a finishing tube, control of molar torque could be achieved in Stage III by a wave form in the base archwire as can be achieved in a flat oval tube (Mollenhauer, 1976). But this does not provide torque for the premolars in Stage III.

In the future, case presentations for Begg study group or society meetings should include clear photographs of the palatal cusps of the upper buccal teeth (natural or study model) which have been disarticulated to view this feature.

RETENTION
It is curious that many writers, even well known Begg practitioners (Kesling, 1985), still illustrate Dr Begg's original retainer as the Begg retainer. In fact, Dr Begg changed to the new format many years before retirement, but this may have only been written up in the Australian Begg Newsletter (Mollenhauer, 1983b).

If the newer Begg retainer is used with the tightening loop at the distal of the last erupted (or about to erupt) molar, then thicker (0.9mm) wire must be used to maintain stability in the anterior region.

The advantage of these retainers is the simplicity of construction and the reduced risk of irritation of the buccal frenum. Because the wire bows of these retainers do not cross the occlusal surfaces they will last for many years without breakage. If the plate is not sucked up and down by the patient then the bow will not become loose. In fact, if the plate is being fully inserted by the patient, particularly during night only wear then, after a few checks, most patients need only be seen every 9-12 months.

For a number of years the author has included a large hole in the palate in the retainers. This has the advantage of improving retention — a feature confirmed by other orthodontists. It also tends to prevent burning of the palate with hot food when the plate is worn at night only. An inclined plane is incorporated in a passive manner to control the Class I relationship (Figure 34) and to provide strength through bulk in the anterior section.

Fixed lower retention
The simplistic theory of the 1960's justified the non-use of lower retention. Those who continue not to use routine lower retention frequently justify the practice by quoting Williams (1985). But we who were fortunate enough to see this remarkable clinician practice were left with the
impression that he exchanged lower retention with 'something else'. This 'something else' was his incredible attention to occlusal harmony and slenderising procedures throughout treatment. These procedures took a considerable amount of personal chairside time.

The fabrication of a fixed banded cuspid-cuspid retainer has previously been described in detail as an example of an expert system rule (Mollenhauer, 1985c). This is the most useful appliance in orthodontics if correctly fabricated and cemented (Figure 35). Due to a series of broken appointments, one patient did not present for removal of the cuspid-cuspid retainer, and did not return. Her dentist rang to point this out nine years after it was fitted! When she eventually did turn up, it was fine.

The fabrication of a fixed banded cuspid-cuspid retainer push the second end, to be welded and soldered, manually to ascertain how much pressure can be exerted on the anteriors to create spacing. This is one advantage of banded retainers over bonded retainers. The same bands as used during treatment, with the brackets cut off, are used to make this lower retainer.

These appliances are particularly useful in the Begg technique because they retain the root movements of the lower cuspids which are often the last teeth to upright. But more importantly, they intercept the lower incisor crowding due to three phenomena. The first cause is the settling in of the anteriors from the overcorrection of the overbite according to the Begg philosophy. The second cause may be aberrant anatomy of the lingual surfaces of the upper anteriors which may produce irregularity of the lower anteriors unless these teeth are retained. Lower retention may prevent upper anterior settling, but trimming and tightening of the retainer bow will overcome the problem, rather than rebonding/rebanding the lower anteriors.

The third phenomena is the distalisation of the lower incisors which happens invariably after treatment as seen on post-treatment tracings. Since this becomes obvious in the majority of cases in three years, such a time span is a useful starting point for evaluating how long the lower fixed retainer is left cemented.

Variables related to when to remove the cuspid-to-cuspid retainer are: amount of mandibular growth left particularly if it is in a horizontal direction, if there is considerable spacing retained, situation of the third molars which should either be fully erupted or removed, original degree of irregularity, if the patient is a Bo Derek.

Male orthodontists would probably prefer to institute long term follow-up for the last variable. One other point probably requires clarification. This is the point about spacing. This is related to the manner in which the author fabricates a fixed lower retainer. It applies the principle of overmovement to retention and also builds in a safety valve for late mandibular growth. That is, unless the case had previously exhibited lower anterior spacing, the retainer is fabricated so that some lower spacing is retained. Whilst this method has been used for many years, a recent article by Little (1987) supports the practice to some degree — cases which had pretreatment spacing showed less crowding in the long term. Unfortunately in some cases all the space collects as a lower midline diastema (Figure 36), but reassurance that it will close is sufficient management.

Sometimes it is prudent to leave lower first molar bands when the others are debanded. Such bands act as separators to encourage settling of the molars if there is some doubt about the contact points (Figure 37). Usually they have performed this task within 3-4 months. Of course, if there is grosser malpositioning, then the brackets may also be left on the cuspid-cuspid retainer and an archwire applied to actively correct the molars (Figure 38). One of the advantages of Begg brackets is that they may be twisted off, and the remnants trimmed down, without the need to remove the cuspid-to-cuspid retainer.

Figure 36. Unfortunately when the band spaces are actively and routinely maintained with the fixed lower retainer, occasionally the spaces collect as a lower midline diastema. Reassurance to the patient is often the best approach initially, but the lingual bar may be cut later.

Figure 37. When the lower molars need a little settling at the time of debanding, the molar bands may be left on for several months to act as separators - to ensure this settling.

Stripping
Whatever terms one uses for the mesiodistal removal of tooth substance (stripping, slenderising or reproximation) there are two levels which could be distinguished —

* Differentiate between stripping and re-facetting.
In this context, stripping refers to the gross removal of tooth substance as opposed to the removal of the wear facets which are seen on the older patient with irregular teeth. On a philosophical basis, the author prefers to simply refacet the proximal surfaces in conjunction with fixed lower retention, so that gross stripping, such as that suggested by Sheridan (1985) can be held in reserve for those individuals who exhibit long term crowding which requires retreatment. This approach arises from the frustration of seeing adults who were treated ten or more years previously with premolar extractions and heavy stripping, and the anteriores have become crowded again. Extraction of four first molars in such cases, especially when wisdom teeth are not present, is not an enviable treatment plan, unless there is a bimaxillary protrusion to be also corrected.

SUMMARY

This has been a sketchy and selected coverage of some of the important developments in the Begg technique, as practised by the author. Orthodontists may find the examples of the Expert System rules contained herein an incentive to develop a more comprehensive set of rules to codify their own expertise. The article has not covered as many important areas of Begg management such as elastics, including the implications of the findings of Weekes (1987) on space wasting using light elastics, which questions the very basis of the differential force system, and elastic distortion (Mollenhauer, 1984c).Yet another area not covered has been the management of midline problems, as exemplified in the rule—

'If there is a midline discrepancy then it should be assessed and possibly corrected while spaces are still present (in Stage II); or severe cases may even require asymmetrical extractions at the outset.'

The article started with a quotation by a physicist about the desirability of identifying relationships between various variables or parts of the technique. To complement this, a quotation from a legal historian one hundred years ago, the article concludes the article:

'Simplicity is the outcome of technical subtlety; it is the end result, not the starting point.'... Frederic W.Maitland (1887)

As orthodontists, we have the simple objective of producing occlusions which have good aesthetics, function and stability, but it is not necessarily simple to achieve that. All variables or factors must be taken into account, rather than using a cookbook approach.

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