CHAPTER 3

ABERRANT FACIAL GROWTH

Chapter one emphasized how long-term muscle 'Posture' can change bony form by inches rather than millimetres even if little obvious force is involved (Fig I/5). Clinicians frequently talk of 'Function' and 'Functional Appliances' despite being aware that 'activity' has little affect on the teeth and bone. However, posture and function are intimately related, contrasting only in time. If you bite your teeth together they will hardly move but keep them in contact over a period of just a few hours and they will certainly do so, even with forces of just a few grams. It is very important that all clinicians understand this and act on it.

As we discussed in chapter I, Proffit suggested that a light force maintained for between four and eight hours a day would maintain a given occlusal height. Indeed the influence of oral posture extends to the Cranial Vault, Basi-cranium and less directly to the spinal vertebra where the phenomenon of 'postural deformity' has been recognized for many years. There has been much debate within Chiropractic and Osteopathic circles on 'Ascending' and 'Descending' influences as some consider that distortion of the lower spine and legs is the initial factor while others believe that many of these distortions arise from birth trauma to the cranial bones.

There is little convincing research in this field because it is almost impossible to measure long-term posture but I am confidant that it will eventually be established that the 'precipitating' factors for malocclusion, include nasal restriction and tongue-between-tooth-swallows, usually arising from reduced muscle tone, soft diet and allergies.

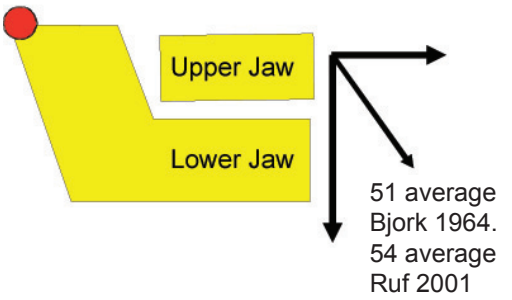
What Actually Goes Wrong?

I hope we can now accept that incorrect oral posture is the major factor in facial mal-development and that its consequence is malocclusion but we still need to have a clear idea of how this happens and what can be done to diagnose and hopefully treat it.

This was a subject that fascinated Arne Bjork. We discussed in the 1st chapter how bone has a tendency to remodel, thus disguising any underlying movement and how this has misled clinicians in the past. Bjork bravely decided to insert metal implants into the facial bones of some of his patients. There is no way that this would be allowed these days and this makes it all the more important to make use of his material. He initially started these studies to discover what happened to the mandible during growth but he soon realized that the maxilla was the crucial bone. His 1966 study showed that the mean direction of maxillary growth for a selected group of 37 boys was 51□ (Figure III/1) but he noted that they "varied individually from almost purely sagital to purely vertical". This is a very wide range and its impact on mandibular growth can be imagined (Figure I/7).

Figure III/1

How the Upper Jaw Affects the Growth of the Lower Jaw



Bjork (1984) showed that the maxilla may grow horizontally or vertically

Bjork was in fact confirming the observations of Schwartz (1961) who demonstrated that all the common malocclusions can be reproduced by swinging the maxilla from an imaginary point 'T' a short distance above it. He suggested that malocclusion was due to the maxilla being, either set down, set back or too small but sadly he was ignored. More recently this was confirmed by Dibbets (1996) who found that "The difference between the Angle classes is the cranial base" and concluded that "... the mid-face above anything else creates the characteristic difference between the three Angle classes, not the mandible." Sadly he also has been largely ignored.

Battagel (1996) showed that lateral skull X-rays do not always demonstrate this displacement and later we will discuss other means of identifying the position of the maxilla. Her work too has been largely ignored. However displacement of the mandible is more obvious than changes to the maxilla which may be why most so called 'Functional' treatment has been directed at the former with little regard to the position of the latter.

A year later, still on the same theme Dibbets and his colleagues (Trotman 1997) made a very interesting observation that if the mouth was left open the face would grow downwards but "Because the sella-nasion dimension shortened proportionately, the SNA and SNB angles were not affected". Many orthodontists fail to take this in to account, but an increase in vertical growth is constantly associated with a reduction in the length of the base of the skull and this disguises some of the change of both the SNA & SNB angles. I drew attention to what I called 'Anterior Facial Collapse' in the 1960s although my first published paper on the subject was not until 1979.

Ruf and his colleagues (2001) superimposed a series of lateral skull X-rays taken from an untreated group in the Bolton series using traditional landmarks and followed changes in the position of the Pogonion over time. They found that the mean growth direction of the mandible was 54º which is presumably a reflection of the 51º for the maxilla suggested by Bjork (1966). We should note that the Bolton cases were not 'ideal' just untreated and in aesthetic terms an angle 54º would seem rather high. As we will discuss later an angle of as high as this is likely to be associated with some facial flattening together with a shortage of room for the wisdom teeth.

At the London School of Facial Orthotropics we aim for a mandibular growth direction of around 40º which is almost always associated with a nice face, little malocclusion and good long-term stability. However these are subjective viewpoints and need to be tested by others because attractive and unattractive faces can certainly be present either side of 45º. The increasing use of Thin Plate Spline Analysis and digital photography should soon enable these comparisons to be made without the use of specific landmarks.

The clues to maxillary growth are in the literature, much of it published many years ago. For instance Sheldon Peck (1970) studied a series of good looking film stars and found that their maxillae and teeth were more 'prognathic' than average. Clearly forward growing faces look more attractive, conversely Lundstrom (1987).found that people with vertically growing faces are less attractive

Interestingly Peck (1970) also found that "The general public admires a fuller, more protrusive dent of facial pattern than customary cephalometric standards would like to permit". This finding was later supported by others (Tedesco 1983) who found that "Lay judges seem to be more sensitive than judges with orthodontic training to dental-facial esthetic impairment". This is not just a Western concept as Soh (2005) using a sample of Chinese subjects concluded that "Orthodontists considered a flatter male profile to be most attractive, but oral surgeons preferred a fuller normal Chinese profile". Later we will discuss my more recent research into facial appearance (Mew 2010) which showed that Orthodontists placed a rather flat face 13th in a sequence of 32 while the lay judges placed it 32nd.

Other basic work by Platou and Zachrisson (1983) showed that patients with 'prognathic' forward growing faces tend to have straighter teeth and it is now generally accepted that horizontally growing faces look nicer, have straighter teeth, are easier to treat, and more stable after treatment.

Muscle tone also plays an important part in determining the amount of this vertical growth. Children, who hang their mouths open, generally have poor body posture and muscle tone. I am not certain of the sequence but logic tells me that few children are born with poor posture or muscle tone. Malocclusion seems more likely to be related to today's soft diets and possibly lack of exercise in general. Whatever the reason normal industrialized four year olds on average leave their mouths open for a worrying 80% of the time (Glatz-Noll & Berg 1991).

While most people might assume that open mouth postures encourage vertical growth there are not many papers to confirm this, although I know of no evidence to suggest the reverse. To some extent this is due to confusion between the terms 'open mouth posture' and 'mouth breathing', for the two are not the same. This will be discussed in greater detail later, but Trotman (1997) found that "A more open lip posture was associated with a downward and backward rotation of the maxilla and mandible a more obtuse gonial angle, a retruded mandible, with retroclined incisors, extruded maxillary molars and maxillary and mandibular incisors, and an elongated total face height caused mainly by a larger anterior face height". This should be a powerful incentive for all growing children to keep their mouths closed.

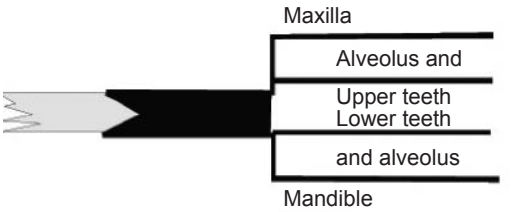
The surprising thing is that most of this information has been known for twenty years or more and yet there has been little change in orthodontic attitudes. Despite the findings, few practicing clinicians are making much effort to change oral posture.

Assessment of Skeletal Relationships.

Angle divided malocclusion into three classes, I, II and III. He then subdivided the Class II into division 1 and division 2. This horizontal classification has the merit of simplicity although it has some obvious shortfalls. Johnson (BJO 1996) extended Angles analysis with his own 'Pitchfork' analysis (Fig III/2) which is widely used to assess the anterior-posterior relationship of the teeth and jaws as separate units. However the 'Pitchfork' is a purely horizontal analysis and fails to allow for vertical changes. Some years ago I suggested the 'Trident' analysis as more appropriate (Mew 1996) (figure III/3) because it is able to allow for changes in the facial angles and head posture.

Figure III/2

Johnson's Pitchfork

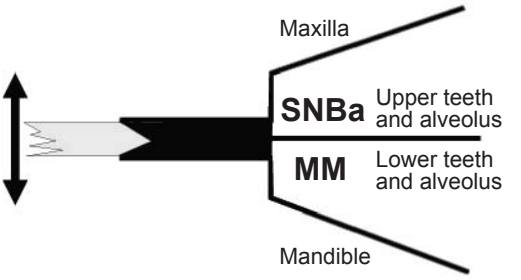


Lylle Johnson's Pitchfork analysis (BJO 1996) which analyses the horizontal relationship of the teeth and jaws as seperate units.,

As discussed in the first chapter the direction of facial growth varies widely between individuals in industrialized societies although there is little variation in truly primitive countries. Failure to recognize the importance of variations in growth direction has severely restricted the progress of orthodontics.

Figure III/3

Mew's Trident



I suggested (BJO 1996) that a Trident analysis was more appropriate because it could allow for changes in the tacial planes.

My own interest in Vertical Growth was raised by a series of cases some of which I have already mentioned (I/6 and I/7). However one case in particular was bizarre as I was conducting some research into the contrasts between the characters of individuals with different shaped faces. This involved comparing a group with mandibular angles of less than 20º and another with

Figure III/4 Environmental Factors

Age 10 Age 17 Age 17

Open Mouth Postures - A boy who delevoped nasal obstruction. Note the change in Growth Direction that followed.

He now has a habitual open mouth posture.

angles over 35º. I asked a psychologist to assist me and the paper was one of first to establish a relationship between facial form and personality characteristics (Squires,R, & Mew, J.R.C. 1981). Short faced people are more conventional, long faced less so.

About five years later the psychologist contacted me to say that he thought his own son was changing from a horizontal to vertical grower. I suggested that he brought him to see me and they came with his mother who showed me a photograph of their son at the age of ten. The change was remarkable (see figure III/4). His mother told me that at the age of ten David had started keeping some pet Gerbils and had subsequently developed an allergy to them. So much so that he had required surgery to restore his airway.

It is interesting to see that although his airway is now patent he has developed the long-term habit of leaving his mouth open. As a result he has suffered in the same way as the unfortunate girl in figure I/7. I was indeed fortunate to witness the change to these two individuals as they gave me the first clues to vertical facial growth.

What goes wrong with Facial Growth?

In 1979 Bjork and his colleagues compared the craniofacial growth of an Australian aboriginal and a Dane. They found that not only was the growth direction very different but interestingly the shape of the individual facial bones changed very little, instead it was the relative positions of the bones that changed. Presumably the Australian kept his mouth closed more. These are important observations to which we will return later.

What is it that initially causes so many children to develop open mouth postures? Bakor and his colleagues (2011) studied tracheotomized children and found as have many others that "Patients having predominantly oral breathing had smaller maxillary widths, mandibular widths, and facial widths compared with nasal breathers (5%)" but rather amazingly also "those who had been tracheotomized (6%)". The tracheotomised children also had higher muscle tone than either of the other groups. Why, one wonders, should a tracheotomy encourage the mouth to close? Does this suggest that it is natural to keep the mouth closed?

It was Luzi (1982) who noticed that the quadrahedron formed by the planes SN, NA, ABa and BaS distorted in a predictable way in all class I patients. As SNA increased NSba reduced so that their combined values always remained the same (Fig III/5): so precise was this that within a random sample of 160 Class I patients the sum of the two angles varied less than 2 degrees (203.5º to 205.4º) as the maxilla hinged back; an almost unique consistency of biological form.

Luzi's work shows that there is a clear and precise inter-dependency between the Saddle angle and ANB; as one increases the other reduces. This explains why forward growing faces have a low saddle angle and vice-versa. It is as though the SN plane was bolted to the base of the skull and the maxilla and its associated bones are free to swing backwards and forwards beneath it, just as Schwartz (1961) said half a century before (is anyone listening out there?).

This is highly relevant to our discussion and I have little doubt that retracting the maxillary incisors in a young child reduces SNA and increases the saddle angle, taking the mandible down and back. This also is a very important concept to understand.

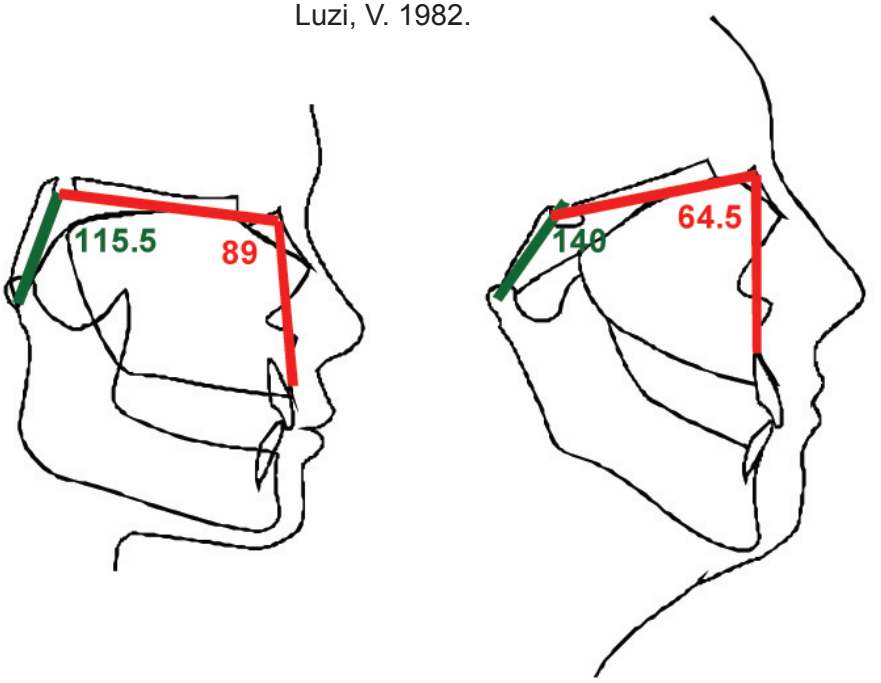
Essentially the smaller the saddle angle, the greater the forward growth of the Nasion and mid-face. These are movements that benefit facial appearance and provide more room for the teeth. (Tanabe et al 2002), and of course the reverse also applies.

These rules also fit class II and III cases but not so precisely. As will be seen later 'Orthotropics' aims to convert all occlusions to class I, and so that Luzi's rule is likely to apply to most Biobloc cases. An enlarged saddle angle is associated with almost all the things that orthodontists don't want. For example a long face, receding chin, flat cheeks, narrow and crowded arches together with recurrent lower incisor crowding.

This obvious conclusion must cast doubt on the wisdom of any treatment that is retractive in nature. Certainly an increasing number of schools have now banned retractive headgear as we will discuss later.

The saddle angle itself can vary quite widely and Timms and Trenouth (1999) found that NSBa ranged from 118 to 138 in a random sample of 82 British school children with malocclusion. However I have seen extremes approaching 150º and 90º and contrasts

Figure III/5 Luzi, V. 1982.



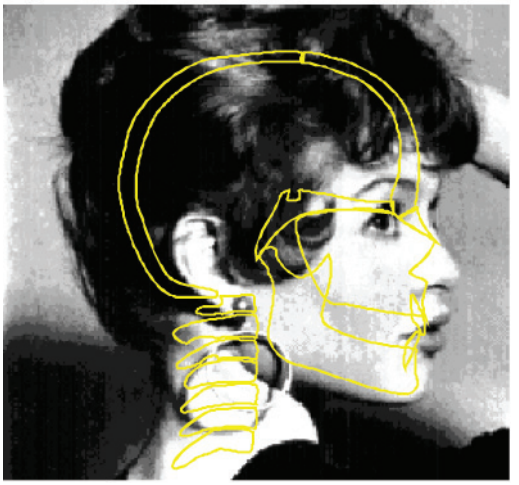
of this size will be associated with entirely different facial forms despite their owners having very similar genes.

Contrasting Growth Patterns.

Figure III/6 illustrates a good looking face and its associated skeleton. Outlines such as this are rare in orthodontic offices and the upright cervical spine should be specially noted. The Saddle Angle (Ba S N) is 111º giving her an attractive forward growing face. Figure III/7 shows a vertically growing face with a Saddle Angle of 136º and curved cervical spine.

As can be seen from Figure II/7 the

Figure III/6

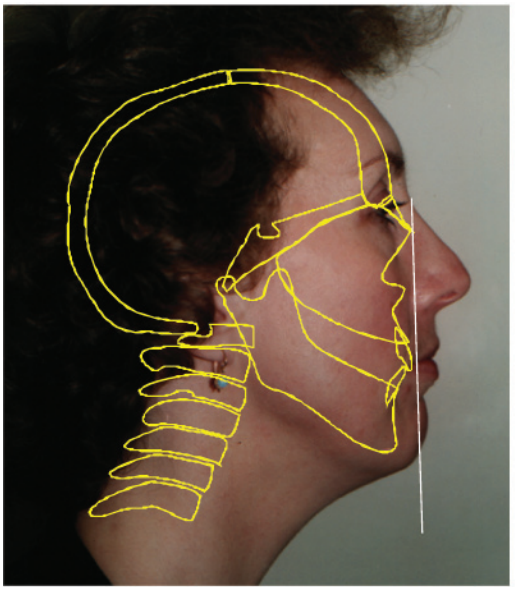


Note the SN plane is nearly horizontal and the cervical spine upright.

dropping of the maxilla is associated with a major change in mandibular form as the vertical ramus remodels forward to protect the airway. Clearly this reduces the length of the horizontal ramus and with it the space for the dental arch, creating another no-no for anything that encourages vertical growth; again an important concept to understand.

It is interesting that despite these facts being known for many years, many clinicians still believe that the cause of most dental crowding is purely a disproportion between arch size and tooth size. Howe et al noted in 1983 that "Statistically the crowded and non crowded groups could not be distinguished on the basis of mesio-distal tooth diameters"

Figure III/7



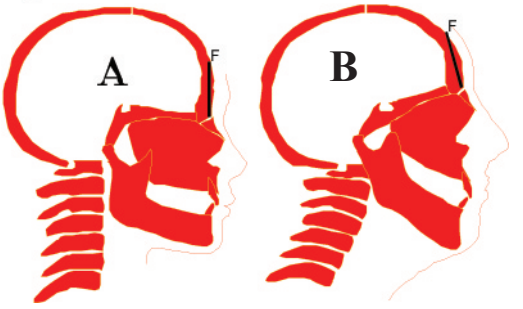
Her profile superimposed. Note how she has tilted her head to keep her face vertical.

and suggested that "Consideration should be given to those treatment techniques which increase dental arch length rather than reduce tooth mass".

This view was supported more recently by Bernabe and his colleagues (2005) who looked at 150 subjects and found that rather than tooth size "arch length is the most important factor" in dental crowding.

Figure III/8 A & B show a vertically growing face beside a horizontal one enabling the contrasts to be seen more clearly. An anthropologist could be forgiven for thinking that they come from different species.

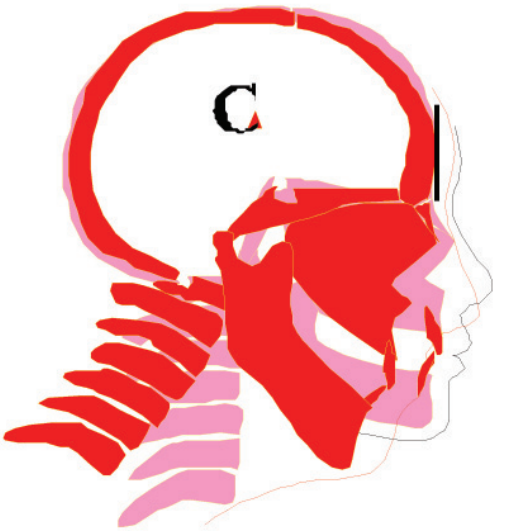
Figure III/8



Clinicians often find it difficult to recognize this rotation on a lateral skull X-ray but an upward tilt of the SN plain is a valuable clue. For many years I have used a point 'F' which is placed on the surface of the frontal bone exactly 40mm above point 'N' to avoid the frontal air sinuses. This enables an accurate superimposition of 'FN' (Fig III/9) to be made at different points of time and it will be found that the angle SNF frequently changes during Orthotropic treatment indicating a movement of the cranial base within the vault. This also explains why so many individuals with big noses also have receding chins and sloping foreheads. I hope that the reader is beginning to understand how logical all this is.

Extremes such as these emphasize the smaller changes that take place in all patients with malocclusion. The compensatory forward curve of the cervical vertebra is necessary to allow the extension of the cranium on the Atlas, so that the weight of the head can be balanced (see figure III/10). This curve can be seen in all vertically growing faces and inevitably leads to compensating curves in the Thoracic and Lumber vertebra with possible long-term spinal consequences.

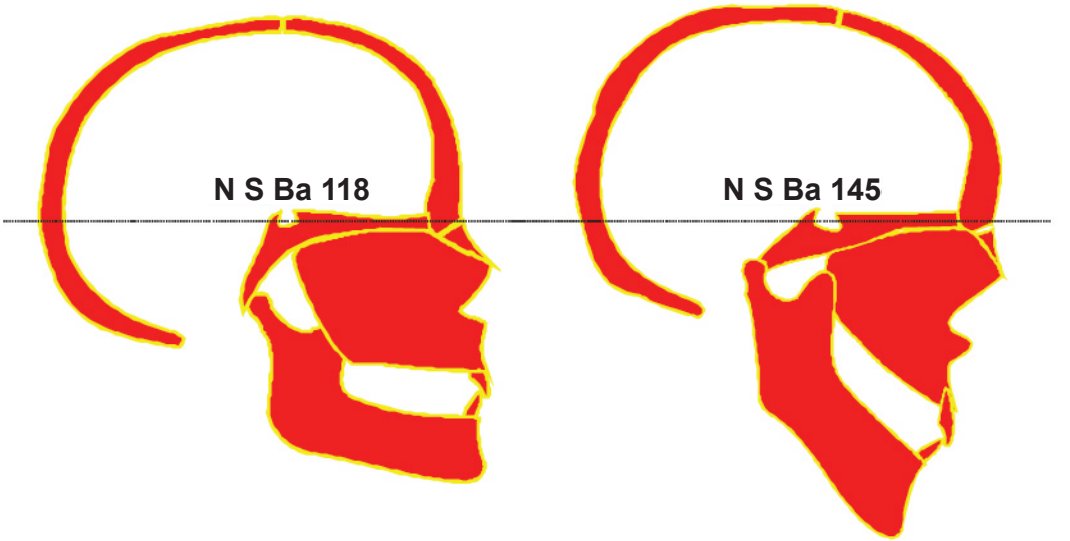
Figure III/9



The skulls from figure II/8 superimposed on 'FN' (the frontal bone).

The rotation of the head in figures III/8, 9 & 10 'B' has restored the facial plane to the upright. Many years ago Marcotte (1981) noticed that regardless of facial form the

Figure III/10



Skulls from figure II/8 & 9 compared on the SN' plane. One could be forgiven for thinking they had come from different species. This demonstrates the drop of the maxilla and its influence on the mandible.

patient would rotate their head so that the Nasion was more or less vertically above the pogonion. Vig (1989) later showed that if the nose was artificially blocked, then within a few minutes the patient would tilt their head back and maintain this posture. This is because opening the mouth causes the mandible to drop restricting the pharyngeal airway. This pharyngeal restriction can be relived by either holding the jaw forward or depressing the hyoid bone but both these postures are tiring to maintain. On the other hand it is easy to extend the head on the Atlas for long periods without any strain. However the remaining cervical vertebra then flex forward in order to restore the overall balance, creating an increased cervical flexure, which is constantly associated with those who leave their mouth open. This rotation which Marcotte observed repositions the chin under the Nasion.

I think I was one of the first (Mew 1983) to describe this sequence, suggesting that "Children who lack lower facial development tilt their heads back to maintain their pharyngeal airway". In the same article I continued "Disproportionate facial growth is to some extent disguised by this backwards tilting of the head, which maintains the facial plane while permitting major adaptive changes to occur in other parts of the cranium".

I have no doubt that this is the sequence that leads to excessive vertical growth as seen in most if not all malocclusions and it is this in turn that precipitates many of the changes in the rest of the spine and limbs. Sadly although this hypothesis was put forward over a quarter of a century ago it still has limited acceptance.

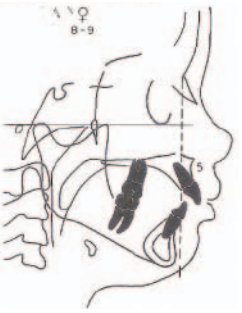
I have been surprised that some orthodontists have had such difficulty in understanding that the collapse of the maxilla is the key to malocclusion. I think part of the reason for this is the associated tilting back of the head so that the face just looks longer with a sloping forehead. The finger of blame must point to the misleading nature of profile X-rays. It is only when one places two such cases with their SN planes parallel is the true contrast of form revealed (figure III/10)

Few cephalometric analyses place the maxilla correctly. Steiner's 'normal' of 82º is to my mind is markedly retrusive; and even McNamara's 'Nasion Vertical' moderately so. Most of these analyses are based on angular relationships so that variations in size can be allowed for but because the lines radiate from the base of the skull this makes it difficult to place the maxilla. In my opinion irregularity of the maxillary incisors rarely occurs until the maxilla itself is set back more then ten millimetres.

The Frankfort plane suffers in the same way; because as the maxilla drops down so does the infra orbital margin, causing the 'FH' to tilt with it. Visually the Frankfort Plane appears to remain horizontal but this is because the patient with a collapsed maxilla will have to tilt their head back to restore their airway, thus restoring the 'FH' to the horizontal. This tilting has an adverse effect on all those analyses which are based on the Frankfort Horizontal such as McNamara's Nasion Vertical (McNamara and Brudon 1993) and figure III/11 taken from his book labels this girl as being 5 millimetres prognathic when in my view her maxilla is down and back and should be taken forward by about the same number of millimetres.

The fullness of the face is usually assessed with the 'SNA' or 'SNB' angles but these are at risk if the associated changes in the Saddle Angle are not allowed for. Also if the face grows vertically the length of 'SN' shortens so that "the sella-nasion dimension shortened proportionately, the SNA and SNB angles were not affected" (Trotman 1997). If the Saddle

Figure III/11



McNamara used his 'Nasion Vertical' to diagnose this girl as being 5 millimetres prognathic but according to an Orthotropic assessment the upper incisors are about 4 mm down and back from the cranial vault.

I consider that any form of retraction in this case would be inappropriate.

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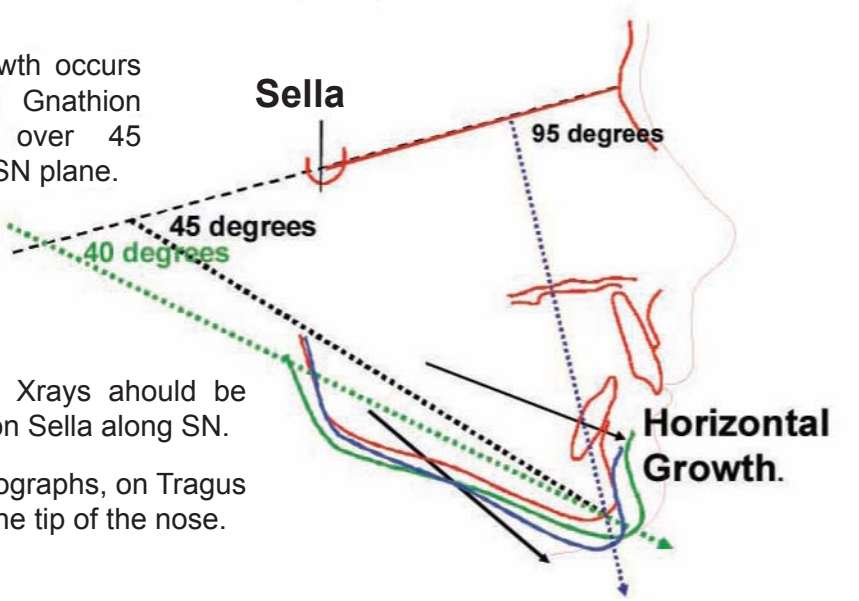
Figure III/12 Vertical Growth

Vertical growth occurs when the Gnathion grows at over 45 degrees to SN plane.



Two sequential Xrays ahould be superimposed on Sella along SN.

Or if using photographs, on Tragus along a line to the tip of the nose.

Angle opens, the resting head posture will change in order to restore the airway and this causes the 'SN' plane tends to cant upwards as is seen on all lateral X-rays of long faces (Fig III/8). Thus superimpositions on this plane would place the maxilla further forward than it really is and many orthodontists are misled by this, diagnosing the face as prognathic (see 'Brian' below Figure III/13).

The ideal direction of maxillary growth is probably around 35º to 40º and it only requires a slight increase in this angle to have a marked effect on the mandible, which maybe why the latter changes its shape more than any other bone in the body. For those who 'Read the Face' the position of the maxilla can more easily be assessed by using measurements such as the 'Indicator Line' and the 'Cheek Line' (to be described. Figure IV/14 & 24).

Because of my scepticism about X-rays, I stopped using them other than for research more than twenty years ago, however I have been strongly criticized for this by those that feel they are indispensable. In my opinion digital photographs provide much more information, especially if compared by using the Thin Plate Spline Analysis but the best information of all comes from a study of the face itself.

Measuring the Direction of Facial Growth.

Various authors have suggested the use of different planes to assess the growth direction but I recommend the use of two sequential X-rays superimposed along the 'SN' plane at 'S' or along the Frankfort Horizontal at the Porion. Alternatively using photographs superimposed on the Tragus

Figure III/13

Brian Age 11. Overjet of 11mm. Slight upper spacing and no lower crowding. Note the curvature of the cervical soine and flattened cheeks, to me this suggests vertical growth.

along the line from there to the furthest point on the nose. It does not matter much which of these plains are used provided the 'before' and 'after' superimpositions are along the same lines. The direction of growth is then measured by marking Gnathion or Pogonion on both tracings and drawing a line through them extending to the plain used for the superimposition (fig III/12).

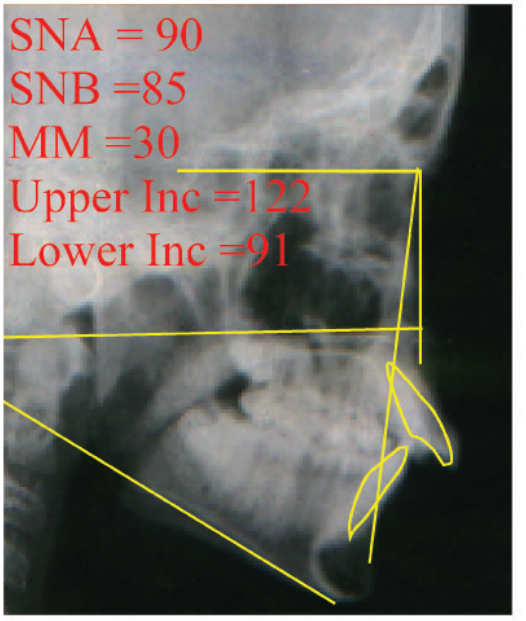
In geometric terms anything less than 45° would be horizontal and anything over would be vertical. 35° to 40° would appear to be close to the functional and aesthetic ideal but there are many nice looking faces and straight teeth associated with angles as high as 50°. Research is difficult on this point as few serial records of outstandingly good looking people are available. However for most severe malocclusions the angle will be over 80°. Some character-full faces are found with high angles but as the growth direction increases there is less and less room available for the teeth. The following two clinical cases confirm the importance of diagnosing maxillary position correctly and the effect of different treatments on the growth direction.

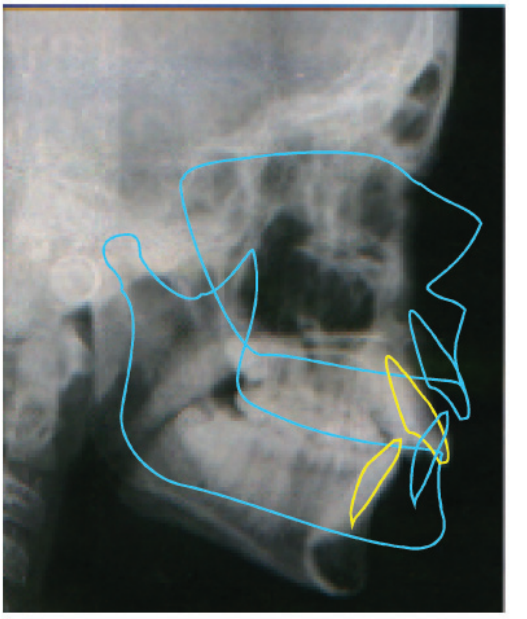
CASE EXAMPLE 1

Brian was an eleven year old boy with a class II division 1 malocclusion and an eleven millimetre overjet. He had a convex face with no crowding in the lower and slight spacing in the upper (figure III/13). Faced with an overjet of 11 millimetres and a convex face, most orthodontists would be thinking of some form of retraction but examination of his face shows that his cheeks look rather flat and it will be noticed that he has quite a curvature in his neck suggesting that his head is extended when in his normal position.

The lateral skull X-ray (fig III/14, left) shows that the SNA is approaching 90° which is considerably higher than most 'norms' which are around 82°. Of interest the records of this particular case were sent to every member of the British Orthodontic Society and they all were asked to provide their own prescription. 91% of those who replied suggested that

Figure III/14





The SNA is 90 suggesting that his maxilla is placed forward. 91% of the British orthodontists recommended extractions and 63% recommended retractive head gear

However if compared with a good looking face, the maxilla and upper incisors are too far back. The SNA is not a safe guide.

extractions of teeth were required, despite the fact that there was spacing in the upper arch and no crowding in the mandible. 63% recommended retractive head gear and a further 15% thought head gear might be required. However the 'Indicator Line' (to be described later) suggested that Brian's maxilla was several millimetres retruded and if the outline (in blue) of a good looking forward growing face is superimposed on Brian's cranial vault (fig III/14 right), this would also suggest that the maxilla and upper incisors are too far back

Brian was treated with extractions and head gear to retract his maxilla and the result is shown in figure III/15. A panel of six lay judges thought his facial appearance on a scale from one (very unattractive) to ten (very attractive) had changed from 5.5 before treatment to 4.2 after. Of interest the mandibular growth direction which should be around 55° for an averagely good looking face increased to 112°.

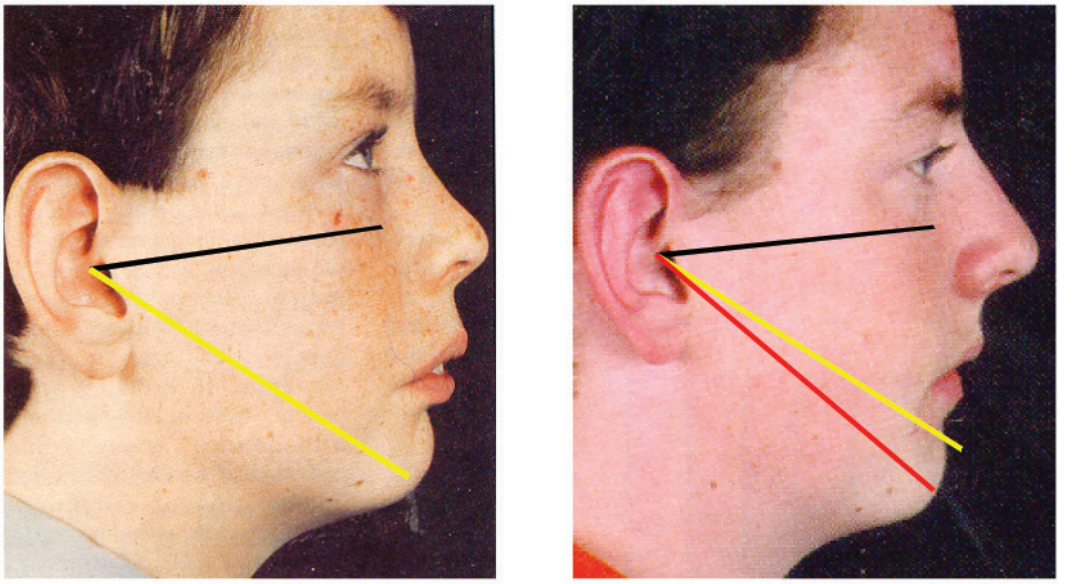
This case was clearly misdiagnosed and mistreated. It reflects a worrying lack of understanding in 1995 amongst the majority of the UK orthodontic specialists about maxillary position and its effect on the mandibular growth. This was probably due to an over reliance on lateral skull X-rays coupled with the use of measurements that do not clearly identify maxillary position.

CASE EXAMPLE 2.

For the sake of comparison let us consider the treatment of a younger girl also with a convex face. Emily is eight years old and has a class II/1 malocclusion with an overjet of 14 millimetres and a complete overbite (fig III/16). Her mother asked for the upper anterior teeth to be retracted. However the Indicator Line (to be described shortly) suggested that they were already too far back and needed moving forward so that the lower jaw could be allowed to come forward as well. Most conventionally trained orthodontists would find this a confusing diagnosis but it serves to illustrate the difference between 'Orthotropics' and almost all other approaches.

The precise method of treatment will be described later but was commenced by moving the maxilla and upper incisors forward so that after four months the overjet had increased from 14 to 17 millimetres (fig III/17). This freed the mandible to move

Figure III/15



Note the "growth direction" was 112 degrees to Frankfort

The Indicator Line increased from +4 to +8

Figure III/16

Emily is eight years old and has a class II/1 malocclusion with an overjet of 14mm and a complete overbite.

Despite the convex profile her maxilla and upper incisors were set back several millimetres relative to her cranium.

It was decided to enlarge her maxilla and move it forward.

forward without interference and she was then trained with appliances to posture into an over jet and overbite of 2mm for twenty two hours a day. Nine months later the overjet had reduced to 3½mm and she stopped day-time wear.

Sadly many orthodontic students are trained to believe that changes of this nature can not be achieved with appliances and would explain the result by saying that Emily had a fortunate forward growth spurt,

Figure III/17

Emily age 8, overjet 14mm complete overbite.

The maxilla was expanded and moved forward.

Four months later. Overjet 17mm

Aged 12. After treatment. No fixed appliances, the lip seal has up-righted the incisors.

which was pre-programmed in her genetic make up. Others might agree that some of the change was due to the appliances but currently (2018) very few would accept that such changes can be achieved predictably with these methods.

Further information is available from the photographs and X-rays. (Figs III/18, & III/19). The facial improvement is probably due to the growth direction which was 37°.

Figure III/18

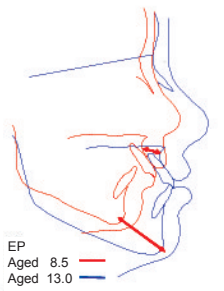
Age 8 Age 12

Emily before and after her treatment Try to visualize the changing relationships of her facial bones.

The Bolton study of untreated but probably not ideal patients found a mean growth direction of 54° (Ruf et al 2001). Sadly it is known that most orthodontic treatment tends to increase vertical growth. This is partly because of the eruptive effect of fixed archwires, partly because of the retractive effect of inter-maxillary traction on the maxilla and partly because most appliances are detrimental to oral posture. These factors will all be considered at later points in this book but for the moment let us consider what actually happened to this young girl.

If the X-rays are superimposed on 'S' along 'SN', it will be seen that 'A' point on the

Figure III/19



Downs point 'A' moved forward 11mm, while Gnathion grew forward 27mm at with a growth direction of 37 degrees.

The untreated patients in the 'Bolton' group had a mean growth direction of 54 degrees

Note the antigonial notch has disappeated.

Maxilla moved forward about 11mm, while Gnathion advanced 27mm. It may be that such changes have been achieved by other methods but I have never been privileged to see them and personally do not think that any treatment other than Orthotropics could achieve this amount of forward growth. The final growth pattern is much the same as might be expected for any good looking child; the unusual feature is that she started with a vertical growth pattern which changed to horizontal during treatment. It is important to note that no fixed appliances were used at any point.

So what actually happened? I do not believe that a mandible can be made to grow more than a few millimetres although we can certainly change its shape. The upper and lower jaws are linked by a series of bones and we discussed in chapter I the ability of each of these bones to remodel and adjust its relationship with its neighbours. Both Bjork's (1979) work comparing the growth of Europeans with indigenous Australians and Lobb's (1987) work with twins demonstrated that large contrasts in the shape and growth of the cranial bones can be achieved by many small changes in relationship rather than form. If each of Emily's facial bones had moved a millimetre or so relative to its neighbours then the combined movement would have been substantial. Remember that these bones can all rotate, cant and remodel.

What really concerns me is that malocclusions like Brian's are still being treated in the same retractive manner with long-term damage to the teeth and face. Also the orthotropic treatment given to Emily is still ridiculed and suppressed by many Universities in the United Kingdom. Worse still, the research we need to compare such methods is blocked by even the most respected authorities, so that the public continue to suffer in the hands of those they should be able to trust.

RESEARCH METHODS.

Having had my first successes with 'Functional' appliances in my early twenties I 'knew' they worked, and it always surprised me that so many orthodontists then, as now, 'know' that they do not. There are many reasons for this, but I think the basic one is that we all have to deliver reliable results for our patients. It is demoralising to tell a patient that you will avoid extractions by making their jaw grow forward and then wait for months with no visible change.

You are not sure if it is because they are not wearing it enough, or whether there are some situations when 'Functionals' really do not work. Contemporary research suggests that skeletal changes are limited to two or at the outside three millimetres, which many clinicians feel is hardly of clinical value. Current conventional belief suggests that any change beyond this 2 or 3 millimetres is in the alveola bone not the skeletal bone. Subsequently you may have to change to headgear or intermaxillary elastics coupled perhaps with the very extractions that you had hoped to avoid in the first place.

Most of us have had this experience and many currently say "well we will try a Functional and if it works, fine, but if not, we will use conventional means", while others avoid Funtional appliances altogether. Certainly attempts to correct any type of vertically growing face are fraught with risk whatever method is used (Parks 2007) and will often make faces look noticeably worse (Faure 1998). Sadly a proportion of these patients continue on to orthognathic surgery. The evidence suggests that Orthotropics can provide a successful result in such cases provided, 1/ there is no genetic deformity (less than 4% of cases), 2/ treatment is started young enough (preferably under the age of 9, depending on severity) and 3/ the clinician and patient do what is required. Physiology is predictable, children and clinicians are not.

The Evidence.

My confidence comes from my personal understanding of the basic evidence but this does not seem to be reflected in the wider world. There is a marked lack of consensus within the Orthodontic Specialty when considering the cause of malocclusion or its appropriate cure. A major problem is the contrast between 'Clinical' Evidence and 'Scientific' Evidence. To many people they have equal significance but in my opinion most clinical papers are overvalued, firstly because many clinicians find it difficult to separate their research results from their personal prejudices and secondly because

of the large and confusing variables found when comparing a disparate group of unrelated patients, treated under different circumstances.

It is also difficult to balance the relative merits of different clinical techniques. For instance, if one treatment is twice as good but takes three times as long, is that good or bad? If, more crucially, it is twice as good but costs three times as much, do we say yes or no? We talk of clinical effectiveness but how broad is our assessment? Our paymasters enforce 'clinical governance' but just how different is this from clinical expedience, and is it what the patients themselves want? If a brain surgeon developed a technique that was twice as beneficial but four times as costly, would the world beat a path to his or her door?

The main problem is that it takes two or more years to correct a malocclusion and another ten to twenty to assess the long-term success. Not only do clinicians retire but patients disappear.

Quality of Clinical Evidence.

Traditionally, the hierarchy of clinical evidence (in reverse order) looks like this.

1/ Anecdotal Reports and Opinions.

2/ Retrospective Studies.

3/ Prospective Consecutive Trials (PCTs).

4/ Random Controlled Trials (RCTs).

To which I would add,

5/ Series of Identical Twins.

Anecdotal Reports

These are condemned by most researchers but they are in fact the foundation of almost all orthodontic treatment. They are also the source of many misconceptions. Regrettably they have in the past been open to abuse by powerful characters that draw their own conclusions from limited facts.

Retrospective Studies.

These are fraught with the risk of bias; sometimes subconscious and sometimes reckless. Even if the study is impartial there is a strong risk that successful patients will be more conscientious about returning for follow ups, than unsuccessful. When patients are selected retrospectively there is also the risk of using selection methods that unfairly skew the result. This can happen with even the most respected researchers, for example Bishara and Jakobsen (1997) compared patients treated with and without extractions and came to the conclusion "When based on proper diagnostic criteria the post treatment changes in the facial profile were perceived as favourable in both the extraction and non-extraction Class II division 1 groups when compared to the pre-treatment profile". However when studying the 'method' we see that "Subjects were selected from 'well treated' patients and that 'poor' treatment results were excluded" (one wonders how these parameters were defined). Of even more concern "Photographs in which there was evidence of mentalis muscle activity (puckered or flattened chin) were excluded". This obviously excluded those with open mouth postures from the final results although this exclusion does not seem to have been applied at the start of the study. In my view the only conclusion that should be drawn from this paper is that "regardless of extractions patients who keep their lips together without effort do not suffer facial damage". In general, retrospective studies tend to find that the method preferred by the author is superior to others and many must be considered suspect.

Prospective Consecutive Trials (PCTs)

These follow groups of patients during the course of their treatment and if required beyond. Because the patients are selected in advance, selection biases can be controlled but this requires the establishment of a rigid acceptance protocol and satisfactory pre-treatment records. They are ideal for comparing different types of treatment although it is wise for treatment to be carried out at different centres to ensure that the clinicians are suitably qualified for and enthusiastic about each type of treatment. With suitable reward most patients can be encouraged to return out of retention but those that fail to do so should still be included in the results on the basis of their last visit.

One of the principal advantages of PCTs is that the costs are minimal, requiring little more than duplication of the records so that they can be lodged at the monitoring centre. Unfortunately they are unpopular with those who believe that growth prediction is unreliable as they worry that unfavourable growth could damage their results and therefore their personal reputation. There is also the element of competition which is considered as undesirable although in the university setting where most of this type of research takes place this should ensure that skilled operators are used.

I described in the first chapter how with the support of British Association of Orthodontists, I set up such a study in 1972 but the university departments were reluctant to expose their results to outside examination. As was found in Shaw's cleft palate research (1992), this type of study shows up clinical weaknesses which may be why such studies are not popular. Shaw's study resulted in some painful realizations and at some centres, heads rolled. Provided record taking is good, PCTs enable the categorization of the different groups to be adjusted retrospectively as well as prior to the study and in my view are by far the best way of establishing the merits of rival treatments.

Random Controlled Trials (RCTs)

These have become standard within medical research and are especially suited to pharmacological trials, but are they appropriate for orthodontics: possibly not for several reasons?

1. 'Blinding' is rarely possible.

2. Appropriate Controls are a basic requirement for almost all medical research. Unfortunately individuals with 32 perfectly straight teeth are rare in civilized societies and there is thus a risk that as we discussed previously, less than perfect occlusions will be used as 'normal controls'. The most commonly used 'normals' are the Bolton, Burlington and Kings College studies, the occlusions of which were 'good' or 'untreated' rather than 'excellent', and available to us only as records. Here we are at risk of comparing one group of 'abnormals' with another, both with retruded maxillae and large variations. If a sample is skewed it can be difficult to obtain meaningful comparisons especially if both the patients and controls are on the same side of the possible range of variables. It is interesting to note that the better the occlusion, the smaller the variation when compared with average population standards, a statistic that researchers should ponder about.

3. Because of the substantial variations between most malocclusions, large numbers of patients are necessary to gain 'significant' results. This requires many operators who inevitably have varying clinical experience. The specific skills of any clinician may vary by a factor of three or even four times, but this is rarely allowed for. Djemal and his colleagues (1999) found that the experience of the operator carrying out treatment "had a pronounced effect which was not readily explained in terms of the distribution of other significant factors".

4. If patients in a trial are distributed randomly, some clinicians may be required to use techniques with which they are not fully trained. This not only raises ethical problems but is of particular relevance to the success of the treatment which can be highly dependent on the clinician's experience and enthusiasm (Djemal et al 1999).

5. Unfortunately the current UK emphasis on teaching fixed appliances means that there are now fewer clinicians with wide experience in Functional or Growth Guidance appliances, especially in the schools where most RCTs are conducted. In a recent very extensive UK study (Robinson 2001) some of the clinicians were not only unfamiliar with the Functional appliances being tested, but in at least one instance had never used them before.

6. RCTs are not very suitable for assessing several variables simultaneously, and yet by reducing the number of variables the results can sometimes be prejudiced. For instance, a recent RCT in the USA reduced the variables by not expanding the maxilla before fitting a Bionator (Tulloch et al 1998). Thus the occlusion was not 'unlocked' and those familiar with Functional appliances would not be surprised to hear that this study failed to show much difference between Headgear, Bionators and controls.

7. However the most important flaw with all research involving functional appliances is that success is almost entirely dependent on the co-operation of the patient and this is almost impossible to ascertain.

Sadly most RCTs in orthodontics have been very expensive and because of problems such as those mentioned above, have tended to produce rather negative results, therefore it may become more difficult for them to obtain funding in the future.

Faced with these difficulties where do we go for the answers that orthodontists need so badly? I think that for orthodontics PCTs are more appropriate than RCTs but unfortunately they are victims of their own success because rival universities are frightened of the PCTs ability to expose failure.

Systematic Searches and Reviews.

As more people come to recognize the failings of RCTs, Systematic Searches have become more popular. However they face many of the same criticisms as RCTs, sometimes representing no more than the average of a number of flawed studies. As Papadopoulos and Gkiaouris conclude after one such review (2007), there is a "lack of high quality research articles in the orthodontic literature". In my opinion it is unreasonable to expect orthodontic research workers to plan good research until they have a sound hypothesis for the aetiology of malocclusion to work around. As we discussed in the last chapter the Tropic Premise seems to fit the available evidence well, but few researchers are familiar with it.

NEGATIVE EVIDENCE.

Unfortunately clinical trials of different orthodontic methods have failed so far to provide sound long-term evidence. In my opinion the best orthodontic research method would be to use identical twins, treated with different techniques by skilled clinicians who were convinced their personal methods were correct, and followed up more that ten years after treatment. However it is very difficult to assemble this type of material and it would undoubtedly present ethical problems. I know of only one such study and we will discuss that later.

It can be disappointing to undertake a major study only to come up with 'negative' findings; but it is important for us to know which relationships do not exist. Unfortunately some clinicians will use negative evidence to make positive statements (a major crime in science). For example saying "there is no evidence to show that early treatment is of benefit". This sounds critical but in reality means just the same as saying "there is no evidence to show that early treatment is not of benefit". For example, in the correspondence columns of a respected Journal a clinician faced criticism because he had said "Temporomandibular joint problems are not caused or cured by orthodontic treatment", this may be true but the only evidence we have is negative, it has never been shown that they do or don't cause or cure problems. He also suggested that there is insufficient evidence to show that Functional appliances work but again, there is little sound evidence either way. Negative evidence is dangerous; and if an inexperienced student designed an experiment that failed to show that gravity existed, would anyone believe him?

The Quality of Orthodontic Research.

Orthodontics has been singled out for some fierce criticism by some of the leading researchers in the world.

David Sackett, Professor of Evidenced Based Research at Oxford said in 1985 "Orthodontics is behind such treatment modalities as acupuncture, hypnosis, homeopathy, and on a par with scientology".

Johnston L.E. Professor at Ann Arbour Michigan. 1990 "Clinical practice ... is at bottom largely an empirical process that is little influenced by theory inferred from any of the life sciences".

Derek Richards Director of Evidenced Based Dentistry Oxford 2000 '. "The current focus of dental schools leans toward the teaching of technical skills rather than scientific thinking".

Bill Shaw Dean, Dean Manchester Dental School. 2000 "Sadly it is hard to see this situation change unless the inadequacy of current (orthodontic) knowledge is acknowledged by its practitioners".

Frankel Rolf. 2001 "A mechanical approach treats a symptom, not the cause".

Papadopoulos M A and Gkiaouris I. 2007. There is a "lack of high quality research articles in the orthodontic literature".

Bondemark and his colleagues (2007) carried out a Systematic Review of long-term treatment results and patient satisfaction. They trawled the world literature and found 1004 abstracts or full-text articles, of which 38 met the inclusion criteria. They found it "astonishing that only a few studies were found on patient satisfaction in the long-term" most of which were of poor quality. They drew attention to the fact that the benefits of treatment are usually assessed by categorical scales from dental casts, radiographs, etc which tend to reflect professional standards rather than patients preferences.

Bondemark continued, "Treatment of crowding resulted in successful dental alignment but the mandibular arch length and width gradually decreased, and crowding of the lower anterior teeth reoccurred post-retention. This condition was unpredictable at the individual level (limited evidence). Treatment of Angle Class II division 1 malocclusion with Herbst appliances normalized the occlusion, however this was followed by relapse which could not be predicted at the individual level (limited evidence). The scientific evidence was insufficient for conclusions on treatment of cross-bite, Angle Class III, open bite, and various other malocclusions as well as on patient satisfaction in a long-term perspective".

They concluded "This review has exposed the difficulties in drawing meaningful evidence-based conclusions often because of the inherent problems of retrospective and uncontrolled study design". As a result it is very difficult to provide the public with easy to understand evidence-based information about the ability of orthodontic treatment to meet their long-term expectations.

Orthodontic research appears to have one of the worst records in medical science, how could this have happened? Inevitably, despite the common basis of our knowledge, beliefs differ and the pattern of clinical practice has been one of great variety, both in relation to time and geographical location. The changes have often been cyclical with succeeding generations opposing each other. As the same evidence is there for all to see, one might make the rather surprising observation, that the clinical practice of orthodontics is more dependent on individual belief than overall knowledge.

It is easy to be impressed by a new item of research but one must not allow this to overlay the importance of earlier work on the same or similar subjects. The problem is that research gives us facts but not reasons, it informs, negates or confirms but it never explains. It requires logic to apply each snippet of new information to our pattern of reality and as we know, there is as yet, little agreement about the cause or cure of malocclusion.

I have been dismayed at the conviction displayed by some orthodontists when expounding their current set of 'empirical rules' and their reluctance to consider alternate views.

What is a profession?

To understand this problem one needs to consider the concept of professionalism. A profession can be defined as "an occupation that has assumed a dominant position in the division of labour so that it gains control over the determination and substance of its own work" (Freidson 1970). Studying professions means studying their exclusionary strategies, their legitimizing tactics and how they seek to maintain their control. Professions usually claim to be the only legitimate authority in their field.

Abbott (1988) provided some interesting insights into the narrow line upon which the professions tread. If on the one hand, the link between diagnosis and treatment is clear, and the professional work is highly routine there is a risk that it can be taken over by semi trained auxiliaries. If on the other hand the professional work is too dependent on inference, the profession is also in a vulnerable position because it has trouble demonstrating its clinical legitimacy on the basis of efficacy. In the later respect the more inference that is required the greater the need for an 'expert'. A clear understanding

of the cause and cure of malocclusion would certainly weaken the establishment's control and trained auxiliaries might be able to move in and provide treatment.

Each sub-specialty of medicine and dentistry tends to lay down lay down its own guide lines, some of which are quite specific and these tend to be maintained by the examination system set up by that specialty. I am sure there are many merits in this arrangement but it does restrict freedom of thought and at times inhibits new developments. If all students believe and practice what they are taught then progress halts. In many professions new concepts are expected to be proven beyond reasonable doubt while existing beliefs are allowed to linger on in full control until convincingly disproved. It is this distortion of the burden of proof that we need to redress because it should be the logical application of the evidence that should guide us not established belief.

These issues are addressed in greater detail in chapter 12.

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