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Orthodontic treatment

It is important that all members of the dental team understand the reasons for undertaking orthodontic treatment and the principal treatment options that are available to the patient, says **Jayne Harrison**, Consultant Orthodontist at Liverpool University Dental Hospital.

Introduction

Orthodontics is the branch of dentistry concerned with facial growth, development of the dentition and occlusion together with the prevention and correction of occlusal anomalies. The main indications for orthodontic treatment are to improve oral function, aesthetics and general dental health. The main aims of orthodontic treatment are, therefore, to eliminate functional problems that may predispose a patient to TMD; encourage the eruption and alignment of displaced or impacted teeth; remove any trauma from occlusion and/or displaced teeth and/or improve facial and dental aesthetics by aligning and levelling the teeth, correcting the overjet and overbite to establish a mutually protective occlusion, within a stable soft tissue environment. The benefits of orthodontic treatment can be considered in terms of reducing the negative impact that a malocclusion has on the dental health and psycho-social well-being of an individual. However, orthodontic treatment does carry risks which include decalcification, root resorption, gingival and periodontal problems and the failure to achieve the aims of treatment. It is important, therefore, that treatment should not be started unless there is a reasonable chance that the patient will benefit from it.

This article aims to outline the process of orthodontic assessment, treatment planning and the treatment modalities available to correct patients' problems.

Assessment of a patient for orthodontic treatment

Before any orthodontic treatment plan is drawn up it is very important to reach a diagnosis and establish a problem list. In order to do this the orthodontist must take a history from the patient and parent (if appropriate) and undertake a thorough examination of the hard and soft tissues of the face and mouth. Special investigations such as radiographs, study models and photographs are also required before arriving at the final treatment plan.

History

In the history, it is important to find out the patient's main concerns, the reasons why they are seeking treatment and their attitude towards treatment together with an assessment of the potential level of co-operation with any proposed treatment. At this point, children should be encouraged to voice their opinions about their teeth and how they feel about the prospect of orthodontic treatment.

Examination

The examination of the patient will include extra- and intra-oral assessments of the skeletal pattern; soft tissues; temporomandibular joints (TMJs) and dental relationships. The skeletal pattern is assessed by examining the patient - sitting in an upright position, looking straight ahead - in the anteroposterior, vertical and transverse dimensions. The lips need to be examined at rest and in function



Quad helix appliance



Transpalatal arch

to determine their competency, position and length. The TMJs need to be checked for signs of temporomandibular disease including joint noises, extent of opening and deviation when opening/closing. The intra-oral examination of a patient for orthodontic reasons is similar to that performed for routine dental patients but puts more emphasis on the inter- and intra-arch relationships. The incisor, canine and molar relationships are assessed together with the overjet, overbite, centrelines – in relationship to each other and the facial centre line – transverse relationships, including crossbites, scissors bites and any associated displacement on closing. The general dental health must also be considered so any active or restored caries should be noted together with an assessment of the patient's level of oral hygiene.

Special investigations

Impressions of the upper and lower jaws are taken and reproduced as study models. The study models are then used to record the treatment from start to finish and are used to observe the changes that take place throughout the orthodontic procedure. Radiographs are a valuable addition to the information gathered during the examination of a patient. They are used to assess facial and dento-skeletal relationships and to identify any missing, unerupted or impacted teeth. The most commonly used radiographs in orthodontics are the orthopantomograph (OPG, OPT), lateral cephalogram and intra-oral views of the teeth in the upper labial segment. Photographs are also taken before treatment commences, during treatment and post-treatment. They record the severity of malocclusion, changes occurring during treatment as well as a useful record of any pre-existing pathology, decalcification or trauma to the teeth.

Problem list

Having gathered information from the patient, the clinical examination and appropriate special investigations, a list of the patient's problems can be put together. This should be an overall

problem list of all the patient's dental problems, not just the orthodontic ones. This means that any pathology eg caries, or gingivitis, needs to be brought under control and treated as a priority before orthodontic treatment is started.

When thinking about the orthodontic problems, again the treatment of any pathology eg impacted teeth, ankylosed teeth, and root resorption, takes precedence. Skeletal discrepancies, in all three planes of space, also need to be recognised, quantified and prioritised. Dental problems including any excessive protrusion or retrusion together with problems involving dental development eg abnormal sequence of development, missing teeth and supernumerary teeth, are then considered. Finally, problems involving crowding and malalignment of teeth are considered.

The timing of orthodontic treatment

In most cases the timing of orthodontic

treatment is related to the stage of dental development.

Deciduous dentition Treatment of crowding or spacing is not indicated in the primary dentition, but crossbites that cause a displacement on closing, whether anterior or posterior, can be treated successfully at this stage.

Mixed dentition Treatment in the mixed dentition can involve the extraction of deciduous teeth, the correction of an anterior or posterior crossbite and/or growth modification.

Early permanent dentition The majority of fixed orthodontic treatment is carried out at the early permanent dentition stage.

Adult dentition Most types of orthodontic treatment, with the exception of growth modification, can be undertaken in adulthood. Orthognathic surgery is best delayed until this stage to ensure that growth has stopped.

Types of orthodontic treatment

In the absence of a skeletal discrepancy, malaligned teeth can be aligned, once sufficient space has been created, using fixed orthodontic appliances. Space can be created in a variety of ways including extraction of appropriate teeth, arch expansion and/or interproximal enamel reduction.

If the patient has a skeletal discrepancy, there are three main approaches to orthodontic treatment:

- 1. Growth modification - growth is used to correct the skeletal discrepancy.** To correct a skeletal discrepancy using growth modification, the patient needs to be growing so this type of treatment is best carried out in the late mixed or early permanent dentition. Growth modification treatment can involve the use of a functional appliance and/or headgear
- 2. Camouflage treatment.** If the patient is near or at the end of growth, mild or moderate skeletal discrepancies may be treated with camouflage treatment that involves the use of fixed orthodontic appliances, often in combination with extractions, to move the teeth so as to disguise the skeletal discrepancy
- 3. A combination of orthodontic treatment and orthognathic surgery to correct the malocclusion and underlying skeletal discrepancy.** If the skeletal discrepancy is severe and the patient is at the end of growth, then the malocclusion and underlying skeletal discrepancy can be treated using a combination of orthodontics and orthognathic surgery.

Functional appliances

Functional appliances are a group of

‘Orthodontics is concerned with facial growth, development of the dentition and occlusion together with the prevention and correction of occlusal anomalies.’



Twin Block appliance



Pre-adjusted fixed appliances

orthodontic appliances that aim to modify the growth of the jaws by using the forces generated within the jaws by using the forces generated within the masticatory and facial muscles.

Most functional appliances are removable but some, eg the Herbst appliance, are fixed to the teeth for the duration of active treatment. The majority of functional appliances have been designed to correct Class II malocclusions eg the Twin Block, Andresen, Harvold, bionator and Frankel appliances. However, some have been modified to correct Class III malocclusion, eg the Frankel FR3 appliance. Functional appliances to correct a Class II discrepancy are designed to hold the mandible forwards often to an edge-to-edge position. For a Class III discrepancy only minimal posterior positioning of the mandible is possible so the mandible is held open and rotated backwards.

Functional appliances are usually worn full time and work in a similar way. For Class II cases, the appliances hold the mandible forwards so that the teeth are not in occlusion, the condyles of the mandible are displaced from the glenoid fossa and the muscles of mastication are stretched. For Class III cases, the appliances hold the mandible in a posterior position and open in an attempt to redirect mandibular growth in a downward and backwards direction. In each case the repositioning of the mandible generates forces that are directed primarily to the teeth but can also have an effect on the growth of the maxilla and/or mandible. There are several theories on how functional appliances bring about the changes they do.

These include the following.

Dentoalveolar changes Evidence on the effects of functional appliances suggests that most of the changes (70-80%) that they bring about are due to changes in the dentoalveolar complex. In Class II cases the maxillary incisors retrocline and the eruption of teeth in the maxillary buccal segments is directed distally during treatment. In the mandibular arch the lower incisors tend to procline and the teeth in the buccal segments erupt in a more mesial direction. The reverse occurs in Class III cases.

Skeletal changes Evidence on the effects of functional appliances suggests that only 20-30% of the changes that they bring about are due to alterations in the growth of the maxilla or mandible. In Class II cases there is minimal restriction of maxillary growth and about 1-3 mm increase in mandibular growth. In Class III cases studies show that there is 1-2 mm increase in maxillary growth and 1-2 mm restriction of mandibular growth. Functional appliances also have the effect of redirecting mandibular growth downwards and backwards. This may not be beneficial in Class II cases but appears to improve a Class III relationship.

Changes in the glenoid fossa Animal studies have shown that when the condyle of the mandible is displaced from the glenoid fossa, it remodels causing the temporomandibular joint and mandible to move forwards. However, the evidence that this also happens in humans is weak and if it does occur, the changes it causes are minimal.

Fixed orthodontic appliances

Fixed appliances can move the teeth in all directions. These appliances are fixed to the teeth and forces are applied by archwires or auxiliaries through these attachments. Fixed appliances can:

- Tip – change the mesio-distal angle of teeth
- Torque – change the bucco-lingual inclination of teeth
- Rotate teeth
- Bodily move teeth.

A fixed appliance has attachments (brackets, tubes, bands), which are attached to the teeth by composite resins (brackets, tubes) or cement (bands).

Phases of treatment

The progress of most orthodontic treatment, using fixed appliances, falls into quite well-defined phases. There are subtle variations on this basic format and patients may be treated with other types of appliances before or as part of their fixed appliance therapy.

Bonding and banding This is normally completed over two or three visits. A typical pattern is to place the brackets on the anterior teeth and separators between the molars at the first visit. At the second visit the bands can then be selected and fitted and the archwires placed.

Levelling and aligning Levelling and aligning involves levelling the curve of Spee (the curve in the occlusal plane in the antero-posterior plane) and aligning the teeth. Alignment is usually carried out over several visits using flexible nickel titanium (eg 0.014" and then 0.018" x 0.025") archwires to align the teeth.

Overbite reduction Overbite reduction is a key stage in most courses of orthodontic treatment because it is impossible to obtain a Class I incisor relationship unless the overbite is fully reduced. Effective overbite reduction needs stiff archwires and only starts to occur when stainless steel archwires, of at least 0.016" diameter, are in place with 0.019" x 0.025" stainless steel archwires being the most effective and bring about most of the overbite reduction. Overbite reduction can also be initiated by an upper removable appliance (URA), with a flat anterior bite plane, used in conjunction with a lower fixed appliance at the start of treatment.

Overjet reduction Overjet reduction is usually achieved by retracting the upper labial segment once the overbite has been reduced. This can be assisted by forward mandibular growth, maxillary restraint, distalisation of maxillary molars and/or advancement of the lower labial segment. Overjet reduction can be brought about using a combination of space-closing mechanics and is usually carried out on a 0.019" x 0.025" stainless steel archwire

– the working archwire. A variety of auxiliaries can be used alone or in combination to reduce the overjet. These include active tie-backs, elastomeric chain or springs between the maxillary molars and canine hooks, Class II elastics and/or headgear.

Space closure Once the overjet has been reduced, any residual space needs to be closed. Several auxiliary attachments may be used to bring this about, eg active tie-backs, nickel titanium closed coil springs, elastomeric chain and Class II or III elastics.

Finishing and detailing Once the desired incisor, canine and molar relationships have been achieved it is usually necessary to finish and detail the occlusion to achieve the best possible occlusion. At this stage careful attention is paid to the position of the brackets and bands because if they are incorrectly positioned, the teeth will not be in their ideal position. It is therefore quite common for brackets or bands to be repositioned at this stage. Inter-maxillary elastics, placed in a variety of patterns, can be used to achieve a well interdigitated occlusion at the end of treatment.

Debond Once the best possible occlusion has been achieved arrangements are made to remove the fixed appliance, clean the teeth and provide the patient with retainers.

Retention Following active orthodontic treatment, it is important that the teeth are held in their new position so that relapse does not occur. This stage of treatment is called retention. Retainers maintain the teeth in the position achieved by active orthodontic treatment whilst the gingival tissues and bone around the teeth heal. Retainers can be removable or fixed to the teeth.

Orthognathic surgery

If a patient has a significant skeletal discrepancy then orthodontic treatment alone may not be sufficient to correct all aspects of the malocclusion and facial disproportion. In such cases it may be necessary to consider orthodontic treatment combined with orthognathic surgery. Orthognathic surgery is that branch of surgery concerned with the correction of dentofacial deformity and particularly with disproportions of the tooth-bearing segments of the jaws, and associated facial skeleton.

Stages of treatment

There are several stages of treatment for patients undergoing a combined orthodontic/orthognathic treatment plan. These include:

History and examination When initially seeing the patient it is important to establish their motivations for treatment. These may include aesthetic concerns regarding their teeth

Assessment of a patient for orthodontic treatment		
History		
	Patient's main concerns	
	Reasons why they are seeking treatment	
	Attitude towards treatment together	
	Potential level of cooperation	
	Medical history	
	Social history	
Examination		
	Extra-oral examination	
	Skeletal pattern	Antero-posterior
		Vertical
		Transverse
	Soft tissues – lips	Competency
		Smile line
		Fullness
	Temporomandibular joints (TMJs)	Sounds
		Opening
		Deviation
	Intra-oral examination	
	Inter-arch relationships	Incisor, canine and molar relationships
		Overjet
		Overbite
		Centrelines
		Cross/scissors bite ± displacement on closing
	Intra-arch relationships	Alignment
	General dental health	Active or restored caries
		Patient's level of oral hygiene
Special investigations		
	Extra-oral examination	
	Radiographs	
	Orthopantomograph (OPG, OPT)	
	Lateral cephalogram	
	Intra-oral views of upper labial segment	
	Photographs	
	Intra-oral	
	Extra-oral	

Phases of fixed orthodontic treatment
Bonding and banding
Levelling and aligning
Overbite reduction
Overjet reduction
Space closure
Finishing and detailing
Debond
Retention

and/or face or functional problems that may give rise to difficulties eating certain foods, signs and/or symptoms of temporomandibular joint dysfunction or a speech impediment.

Preliminary planning At this stage an assessment of where the skeletal discrepancy lies, in all three planes of space, is made to establish what surgery will be required to correct it. The surgery may involve the maxilla, mandible or both jaws and occasionally other procedures eg genioplasty. From an orthodontic point of view, the expected tooth movements needed to be undertaken pre-surgically and extractions necessary are planned.

Pre-surgical orthodontics The aims of pre-surgical orthodontics are to maximise the

benefit of the surgery. In order to do this it is usually necessary to:

- Relieve crowding. Just like in conventional orthodontics, any crowded teeth are aligned during the pre-surgical phase
- Correct centre-lines. The centre-lines need to be corrected relative to the facial centre-line and those of the individual jaws
- Decompensate. During the development of a malocclusion the upper and lower incisors tend to compensate for the underlying skeletal discrepancy. The implication of compensation on orthognathic surgery is that the amount the jaws can be moved is limited so, in order to maximise the movement of the jaws the surgeon can undertake, the incisors usually have to be moved so that they are at the correct angle to their respective jaw
- Co-ordinate the arches. The width of the arches often needs to be adjusted so that they fit in a normal bucco-lingual relationship when the jaws are in their new position after surgery
- Level or maintain the curve of Spee. This depends on the presenting malocclusion.

Final planning At this stage full records of the patient are taken so that a check can be made that the planned orthodontic tooth movements have been achieved. Special attention is paid to the centre-lines, incisor angulation and fit of the arches. At this point, the amount of skeletal movement required to correct the malocclusion, in all three planes of space, can be determined. Working study models are made and mounted on an articulator so that the anticipated jaw movements can be simulated and the planned occlusion achieved. From these models acrylic wafers are made that the surgeon uses to guide the teeth and jaws into position during the surgery.

Surgery In theory it is possible to move the jaws in three planes of space, however, some movements are harder to do or not as stable as others. The most frequently carried out surgical movements in the maxilla are advancement, expansion, impaction and down fracture with bone grafting. In the mandible advancement and set back are the most common procedures.

Most procedures these days are carried out from within the mouth so that it is rare for patients to be left with any external scars following surgery. The jaws are usually held in their new position by small titanium plates or screws. The main complications of these specific procedures are nerve damage, swelling and bruising. These usually resolve over the following weeks or months but a small proportion of patients will be left with a small area of numbness or altered sensation overlying



Top: Pre-treatment, Middle: Mid-treatment, Bottom: Post-treatment

the exit of the nerve from the respective jaw.

Post-surgical orthodontics Immediately after surgery it is common for patients to have a limited number of teeth in occlusion. The aims of post-surgical orthodontics are therefore to maintain the surgical correction achieved; level the curve of Spee if necessary; close down the lateral open bites; finish and detail the occlusion to achieve maximal intercuspation.

Debond and retention – As for fixed appliance treatment.

Summary

Patients present for orthodontic treatment with a very wide range of problems and deciding which treatment to provide them with depends on the diagnosis, ie what's wrong. Once the orthodontist has reached a diagnosis and formed a problem list, then the appropriate treatment to correct the patient's problems can be selected from the range that is available to the specialist orthodontist.

‘The most frequently carried out surgical movements in the maxilla are advancement, expansion, impaction and down fracture with bone grafting.’