

2013

# Commissioning guide:

## Orthognathic Procedures



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Endorsed by: [British Orthodontic Society](#)

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## Introduction

Orthognathic treatment is defined as the treatment of dento-facial deformities. This includes patients with named syndromes and conditions including:

- cleft lip and palate
- obstructive sleep apnoea
- hemi-facial microsomia
- condylar hyperplasia
- post-traumatic jaw deformities and malocclusions
- patients with significant jaw deformities which result in functional and psycho-social disadvantage

The aforementioned patients commonly have dental malocclusions that cannot be managed by orthodontic treatment alone. All of these conditions are relatively uncommon but can have serious detrimental effects on patients in terms of function and integration in society.

Although the majority of patients that present for orthognathic treatment are young adults, older patients also present with worsening symptoms and request treatment. Treatment is usually carried out following cessation of growth.

There were over 2718 orthognathic surgical procedures undertaken in England in 2012. There is a wide variation in numbers treated across England, as demonstrated below:

Figure One



This graph shows the number of orthognathic surgical procedures per 100,000 population per Clinical Commissioning Group (CCG) across England in 2012. Each bubble represents a CCG, with the size of the bubble representing the number of procedures undertaken. This information is available in an [interactive web based tool](#) allowing CCGs to drill down into their own data.

Without appropriate orthognathic treatment:

- many of the aforementioned conditions cannot be adequately corrected
- there may be potential complex ongoing treatment needs to deal with the long-term oral sequelae of lack of functional correction
- the patient may suffer ongoing psycho-social disadvantage resulting from their facial and jaw deformity and unusual appearance

Evidence of effectiveness of orthognathic treatment

Functional problems, including trauma to oral soft tissues, difficulty chewing certain foods, speaking, temporomandibular joint problems, sleep disorders and the potential for future dental problems, motivate many patients to seek orthognathic treatment. Significant functional improvements have been demonstrated in a number of studies.<sup>8, 24</sup>

The beneficial effect on quality of life for orthognathic interventions has been extensively demonstrated. Many interventions undertaken in the NHS aim to enhance quality of life (e.g. cleft lip and palate surgery) and orthognathic treatment has important quality of life benefits.<sup>6,7,8,9,12</sup> Most orthognathic patients with jaw deformities are relatively young when they undergo treatment and therefore derive life-long benefit. The cost-effectiveness of this treatment has also been convincingly demonstrated.<sup>42</sup>

All clinical interventions carry some risk; potential risks include oral health impact as part of the orthodontic process and swelling, bleeding, nerve damage and infection as part of surgery. The risk benefit ratio must be considered for each patient and the general medical status of the patient taken into account as part of the shared decision making process before patients are committed to treatment. More information about the occurrence of complications in orthognathic treatment is described in section 4 of the appendix (page 15).

See Appendix A (review of literature) for further details.

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## 1 High Value Care Pathway for orthognathic procedures

### Referral

Referral to either consultant maxillofacial surgeons or consultant orthodontists may come from general medical practitioners, general dental practitioners or primary care specialist orthodontists. Following initial assessment patients are referred to a multi-disciplinary specialist facial deformity (orthognathic) clinic.

### Indications for referral

Patients with significant dento-facial deformities causing functional or psycho-social problems should be referred for assessment.

### Treatment in secondary care

Patients are individually assessed, the risks and benefits of treatment considered, and if appropriate, a treatment

plan is formulated and discussed with the patient. Assessment includes:

- oral health needs
- general medical and social history
- orthognathic clinical, radiographic and photographic examination
- psychological assessment and, where appropriate, referral for specialist psychological evaluation
- patients may also be put in contact with appropriate support groups

Treatment plans are based on individual patient need.

Treatment involves three essential stages:

#### 1. Pre-surgery orthodontics

This involves the preparation of patients for surgery by correcting abnormal tooth position due to the underlying jaw deformity. This generally takes 18-24 months, with appointments every four to six weeks.

#### 2. Surgery

This is carried out on an inpatient basis. A typical length of stay is around two nights. Post-surgical intensive care is rarely required.

#### 3. Post-surgery

Postoperative recovery time is typically two weeks following a single jaw procedure and three weeks following a bimaxillary (upper and lower jaw) procedure.

Two surgical outpatient reviews in the immediate post-operative period are required. A period of post-surgical orthodontics is then required on a six weekly basis for up to twelve months.

In line with national audit recommendations, centres should review patients post treatment following removal of orthodontic appliances for at least two years (this involves two to three appointments).

### **Where should treatment take place?**

Treatment is carried out in specialist maxillofacial surgery/orthodontic centres by appropriately trained clinicians. There is evidence that centres that undertake a high volume of cases are more efficient in terms of operating time and patient stay, as described in section 4(b), page 16, of the Appendix A.

## 2 Procedures explorer for orthognathic procedures

Users can access further procedure information based on the data available in the quality dashboard to see how individual providers are performing against the indicators. This will enable CCGs to start a conversation with providers who appear to be 'outliers' from the indicators of quality that have been selected.

The Procedures Explorer Tool is available via the [Royal College of Surgeons](http://www.rcs.org) website.

### 3 Quality dashboard for orthognathic procedures

The quality dashboard provides an overview of activity commissioned by CCGs from the relevant pathways, and indicators of the quality of care provided by surgical units.

The quality dashboard is available via the [Royal College of Surgeons](http://www.rcs.org) website.

### 4 Levers for implementation

#### 4.1 Audit and peer review measures

The following measures and standards are those expected at primary and secondary care. Evidence should be able to be made available to commissioners if requested.

| Measure  | Standard   |
|--|--|
| Orthognathic outcome audits including patient satisfaction surveys | Providers can demonstrate collection of data for orthognathic outcome audits |
| National Facial and Oral Research Centre (NFORC)                   | Provider submit data to the National Facial and Oral Research Centre (NFORC) |

#### 4.2 Quality Specification/CQUIN

| Measure   | Description  | Data specification (if required)          |
|---|--|---|
| Length of stay                                    | Demonstrates lack of deviation from national average     | Data available from HES                   |
| Readmission and reoperation rate at 7 and 30 days | Demonstrates lack of deviation from national average     | Data available from HES                   |
| Post-operative complications                      | For example infection, fixation removal and nerve damage | As measured through local audit databases |

## 5 Directory

### 5.1 Patient Information for orthognathic procedures

| Name                   | Publisher      | Link  |
|------------------------|----------------|---|
| BAOMS                  | BAOMS          | <a href="http://www.baoms.org.uk/What is Oral and Maxillofacial Surgery/Sub specialist Areas/Orthognathic Surgery">http://www.baoms.org.uk/What is Oral and Maxillofacial Surgery/Sub specialist Areas/Orthognathic Surgery</a> |
| BOS website            | BOS            | <a href="http://www.bos.org.uk/index/patientinformationletters/Orthognathicsurgery">http://www.bos.org.uk/index/patientinformationletters/Orthognathicsurgery</a>   |
| BOS DVD                |                | <a href="http://www.bos.org.uk/publicationslinks/Publications+relevant+to+Members/Jaw+Surgery/jawsurgerydvd">http://www.bos.org.uk/publicationslinks/Publications+relevant+to+Members/Jaw+Surgery/jawsurgerydvd</a>             |
| Saving Faces website   | Saving Faces   | <a href="http://www.savingfaces.co.uk">http://www.savingfaces.co.uk</a>   |
| Changing Faces website | Changing Faces | <a href="https://www.changingfaces.org.uk">https://www.changingfaces.org.uk</a>   |
| Let's Face It website  | Let's Face It  | <a href="http://www.lets-face-it.org.uk">http://www.lets-face-it.org.uk</a>   |

### 5.2 Clinician information for orthognathic procedures

| Name          | Publisher | Link   |
|---------------|-----------|--|
| BAOMS website | BAOMS     | <a href="http://www.baoms.org.uk">www.baoms.org.uk</a> |
| BOS website   | BOS       | <a href="http://www.bos.org.uk">www.bos.org.uk</a>     |

## 6 Benefits and risks of implementing this guide

| Consideration   | Benefit  | Risk   |
|-----------------|--|--|
| Patient outcome | Improved function and psycho-social well-being | Detriment to long term oral health, function and psycho-social well-being if treatment is not undertaken |
| Patient safety  | Treatment by appropriately trained             | Inappropriate interventions  |



|                           |   |   |
|---------------------------|---|---|
|                           | and experienced clinicians in specialist units  | and adverse outcomes if appropriate specialist pathway not followed   |
| <b>Patient experience</b> | An efficient and patient-centric process to achieve an optimal outcome  | Sub-optimal patient experience and outcome if the appropriate pathway is not followed or if patient is unable to access treatment |
| <b>Equity of Access</b>   | To ensure equal access to effective orthognathic treatment by appropriate referral and full specialist assessment | Lack of awareness of benefits of treatment and existence of service by referring clinicians could lead to deprivation of access   |
| <b>Resource impact</b>    | Clear referral guidelines in order to reduce inappropriate referral   | Resource required to maintain adequate training, specialist units and manpower  |

## 7 Further information

### 7.1 Research recommendations

- Targeted research on orthognathic treatment
- Improved techniques; technical developments may streamline treatment in the future and reduce length of stay
- Assessment of outcomes including further development of PROMs

### 7.2 Other recommendations

- Continued engagement with National Facial and Oral Research Centre (NFORC) for national data collection and audit of outcomes, including patient-centred outcomes

### 7.3 Guide development group for orthognathic procedures

A commissioning guide development group was established to review and advise on the content of the commissioning guide. This group met five times, with additional interaction taking place via email.

| Name                       | Job Title/Role  | Affiliation                    |
|----------------------------|---|--------------------------------|
| Mr Paul Johnson            | Consultant Maxillofacial Surgeon and Chair              | BAOMS                          |
| Professor Iain Hutchison   | Consultant Maxillofacial Surgeon; Founder, Saving Faces | BAOMS, Saving Faces            |
| Mr Stephen Walsh           | Consultant Maxillofacial Surgeon                        | BAOMS                          |
| Mr Dean Kissun             | Consultant Maxillofacial Surgeon                        | BAOMS                          |
| Professor Nigel Hunt       | Professor/Honorary Consultant in Orthodontics           | BOS                            |
| Professor Susan Cunningham | Professor/Honorary Consultant in Orthodontics           | BOS                            |
| Dr Justin Shute            | Consultant Liaison Psychiatrist                         |                                |
| Ms Nikkie Garnham          | Medical representative                                  | Medical and Lay representative |
| Mr Graham Pettett          | IT consultant   | Patient representative         |
| Dr Jackie Sowerbutts       | Dental Public Health lead, Surrey County Council        | General Dental Practitioner    |

### 7.5 Funding statement

The development of this commissioning guidance has been funded by the following sources:

- DH Right Care funded the costs of the guide development group, literature searches and contributed towards administrative costs.
- The Royal College of Surgeons of England and the British Association of Urological Surgeons provided staff to support the guideline development.

### 7.6 Conflict of Interest Statement

Individuals involved in the development and formal peer review of commissioning guides are asked to complete a conflict of interest declaration. It is noted that declaring a conflict of interest does not imply that the individual

has been influenced by his or her secondary interest. It is intended to make interests (financial or otherwise) more transparent and to allow others to have knowledge of the interest.

| Name              | Job Title/Role         | Interest   |
|-------------------|------------------------|--|
| Ms Nikkie Garnham | Medical representative | <ul style="list-style-type: none"><li>Medical representative for surgical equipment manufacturer</li></ul> |

## APPENDIX 1.

### A review of the literature and evidence base

This review of the literature presents the evidence for the benefits of orthognathic treatment, whilst highlighting some of the concerns which limit its use in certain clinical situations.

1. Enhanced oral function
2. Enhanced quality of life (QoL)
3. Good cost effectiveness
4. Low morbidity
5. Treatment of obstructive sleep apnoea/hypopnoea syndrome (OSAHS)
6. Treatment of temporomandibular joint dysfunction (TMD)
7. Treatment for speech problems

### Introduction

When an adult patient presents with a dentofacial discrepancy, the alternative to orthognathic treatment is often “no treatment” which makes high level research difficult in terms of performing RCTs, recruiting control groups etc. In some areas of medicine and surgery, different treatment interventions can be compared but this is generally not feasible or ethical in orthognathic treatment. This is important when considering the evidence which is presented in this document.

#### 1. Enhanced oral function

Functional problems, including biting, chewing, speaking, temporomandibular joint problems, and the potential for future dental problems, motivate many patients to seek orthognathic treatment (Hunt and Cunningham, 1997; Stirling *et al.*, 2007; Forssell *et al.*, 1998; Proothi *et al.*, 2010; Alanko *et al.*, 2011). In a systematic review of the literature between 2001 and 2009, 33 to 60% of individuals reported functional problems as the motivation to undergo treatment (Alanko *et al.*, 2011). Studies by Proothiet *al.* (2010) and

Forssellet *al.*(1998) also noted that functional difficulties were the primary motivation, with functional issues of greater concern to patients than aesthetic issues.

Early studies of orthognathic outcomes highlighted the potential for functional improvements. For example, the large controlled study conducted by Kiyak and colleagues at the University of Washington, Seattle, in the 1980s looked at the impact of orthognathic surgery up to 24 months following surgery and found significantly fewer concerns about functional problems at 24 months after surgery than before (Kiyaket *al.*, 1982a, 1982b, 1984). Studies since then have also continued to report such improvements.

Changes in dental function are difficult to measure objectively and, because of this, improvement in function is often assessed using quality of life measures with sub-sections/domains specifically related to oral function and the impairment of biting, chewing, swallowing etc. This important method of assessing function should not be overlooked. Cunningham *et al.* (2000, 2002) reported the development of a quality of life measure called the Orthognathic Quality of Life Questionnaire (OQLQ) which incorporates a “Function” domain and the longitudinal data generated in the development of this questionnaire illustrates significantly enhanced function following orthognathic treatment. A number of other studies also give important evidence regarding functional changes following treatment, including Murphy *et al.* (2011), Lee *et al.* (2008) and Motegiet *al.* (2003), all of whom used oral health-related quality of life measures and demonstrated statistically significant improvements in oral function following orthognathic treatment.

A recent prospective controlled study by Ølandet *al.* (2010) studied 118 patients undergoing orthognathic treatment and compared them with 47 matched controls. Function was assessed pre- and one year post-surgery using a questionnaire and structured interviews; patients were also examined clinically using a Dysfunction Index. The researchers found that function was greatly improved following orthognathic treatment and concluded that orthognathic treatment improves oral function in most cases and satisfaction correlated with the perceived, reported, and measured function at the end of the treatment. This same trend of improved oral function following orthognathic treatment is reported by other, albeit less powerful studies, for example, van den Braberet *al.* (2006), Kharratet *al.* (2006) and Khadkaet *al.* (2011).

Some studies have shown that certain types of dentofacial problem result in significantly poorer function and bite force than others. For example, Hunt and Cunningham (1997) found that patients with long faces/increased vertical facial dimensions, had significantly poorer bite forces than normal prior to treatment and that function improved to normal levels following orthognathic intervention. However, several studies have shown that these improvements in function, particularly masticatory efficiency, may take some time after treatment and this is one of the reasons that good long-term follow up is required in both research studies and clinical practice. For example, Magalhaeset *al.* (2010) found that the positive effects on bite force took up to 5 years post-surgery to be achieved.

Research in the Restorative literature has looked into whether the “shortened dental arch” (ie. a reduced number of tooth contacts compared with normal) affects dental function. Research generally agrees that a complete dental arch with all teeth is preferable (Witter *et al.*, 1990, 1999) and Käyser (1990) stated that preference should be given to dentitions comprising complete dental arches or 14 occluding pairs of teeth. The health care rationing process in Holland also suggested that it was reasonable for patients under 35 years to have at least 12 occlusal units (1<sup>st</sup> molar to 1<sup>st</sup> molar occlusion), from 35 to 55 years 10 occlusal units (premolar to premolar occlusion) and above 65 years to have 8 occlusal units. Many patients who present for orthognathic treatment have a limited number of occlusal/tooth contacts (for example, anterior open bites where only the terminal molars are in contact) and restoring this function can be compared with the restorative replacement of teeth in those patients who have missing teeth due to decay, periodontal disease or developmental absence. Furthermore, Walls *et al.* (2000) noted the restricted diet seen in patients with missing posterior teeth and commented on areas where altered food choices may be a consequence of reduced masticatory efficiency and may place individuals at increased risk of general health conditions. The same argument may be made in those orthognathic patients who have a large number of the teeth which are not in occlusion.

Overall, the evidence indicates that orthognathic patients have compromised dental function prior to treatment and that this does improve significantly post-treatment.

## 2. Enhanced quality of life (QoL)

The constitution of the World Health Organization (WHO) defines health as "A state of complete physical, mental, and social well-being not merely the absence of disease . . ."

It therefore follows that the measurement of health and the effects of health care must include, not only an indication of changes in the frequency and severity of diseases, but also an estimation of well-being and this can be assessed by measuring improvement in the quality of life related to health care (WHOQOL, 1997). For this reason it is vital to consider the potential QoL benefits of orthognathic intervention.

In today’s society, there is no doubt that it is a very real disadvantage to look different. Evidence has shown that attractive people are generally viewed more favourably and attractive individuals are often judged to be happier, more sociable, and more successful than less attractive people; the so-called “what is beautiful is good” stereotype (Dion *et al.*, 1972; Eaglyet *al.*, 1991). The face is the body’s most visible part and the face and mouth are probably the most important elements of social interaction; we are recognised and judged by our facial appearance and communicate with others through speech and facial expression. The desire to change one’s dentofacial appearance is therefore much more than a superficial wish and is influenced by the complex relationship between that individual and society’s response to them. It is therefore not surprising that orthognathic treatment which changes the structure, function

and appearance of the face/mouth enhances QoL in the vast majority of cases; with satisfaction for outcome and process standing at over 90% in a large number of UK wide audits.

The WHO definition highlights how important QoL is as an outcome measure in any medical or surgical intervention. Many interventions undertaken in the NHS aim to enhance QoL and orthognathic treatment is a procedure which has important QoL benefits. It is also important to consider that most orthognathic patients are relatively young when they undergo treatment which means that the benefits obtained from treatment are accrued over a long time period; often 40-50 years at least.

Oral health related quality of life is a complex multidimensional concept. In order to have optimum quality of life requires the absence of impairment, disease or symptoms; the presence of good physical functioning (e.g. biting, chewing and swallowing); and also good emotional and social functioning. There is evidence to show that pre-treatment orthognathic patients have poorer quality of life than those with no dentofacial problems (Lee *et al.*, 2007; Rusanenet *et al.*, 2010) and that oral health related quality of life improves after orthognathic treatment (Cunningham *et al.*, 2002; Esperão *et al.*, 2010; Murphy *et al.*, 2011).

Systematic reviews of the literature also support these findings. In 2001, Hunt *et al.* undertook a systematic review which showed that orthognathic patients experienced psychological benefits, including improved self-confidence, body and facial image and social adjustment as a result of treatment. A more recent systematic review also noted that orthognathic treatment resulted in improvements in well-being (Alanko *et al.*, 2010).

### **3. Good cost effectiveness**

When considering the management of patients with dentofacial discrepancies, it is important to balance the costs incurred as a result of orthognathic intervention with those which may be incurred by the NHS if treatment is not undertaken. If treatment is not undertaken there may be adverse dental effects, including problems such as wear of the teeth, and this may result in costs incurred through dental rehabilitation in such situations.

Cunningham *et al.* (2003) calculated the cost per QALY for orthognathic treatment. Cost per QALY is the standard method of economic evaluation which has been used worldwide in the justification of many different forms of treatment (Drummond *et al.*, 2005). The benefits of treatment are then presented as QALYs gained rather than being assessed directly. The overall cost/QALY for bimaxillary surgery (moving both upper and lower jaws) was £546/QALY gained and for single jaw surgery this cost was £617/QALY gained. This demonstrates that orthognathic intervention provides good outcomes for a relatively low cost. In addition, as highlighted later in this document, orthognathic treatment carries low risk and a low incidence of relapse and reoperation.

It must, of course, be acknowledged that the figures given in the Cunningham *et al.* (2003) paper will have increased with inflation in the last 10 years. Using an inflation calculator, the 2013 costs per QALY in the Cunningham *et al.* study would be £699/QALY for bimaxillary surgery and £790/QALY for single jaw surgery (<http://www.thisismoney.co.uk/money/bills/article-1633409/Historic-inflation-calculator-value-money-changed-1900.html>). When compared with the cost per QALY for other medical or surgical procedures in the UK, orthognathic treatment provides good value for money. Three randomly selected examples from the literature are given below for comparison:

- Clinical- and cost-effectiveness of pegylated interferon alfa in the treatment of chronic hepatitis C: incremental cost per quality-adjusted life year (QALY) for pegylated dual therapy compared with nonpegylated dual therapy for treatment of Hep C was £12,123 (Shepherd *et al.*, 2005).
- Cost-effectiveness of an improving access to psychological therapies service: cost per QALY gained between £16, 857 and £29, 500 (Mukuria *et al.*, 2013).
- Predicting the cost-effectiveness of total hip and knee replacement: The cost per QALY for total hip replacement was £1,372 compared with £2,101 for total knee replacement (Jenkins *et al.*, 2013).

NICE (2004, 2008) recommended a threshold cost per QALY of £20,000-£30,000 for procedures to be funded in the NHS and orthognathic treatment is far below this threshold. The World Health Organization has also suggested that the cut-off for an acceptable cost per QALY is 3x the GDP per capita of the country (Eichler *et al.*, 2004). In 2011 the UK GDP per capita was estimated at £22,000 (International Monetary Fund), again suggesting that this treatment has an acceptable cost per QALY.

#### 4. Low morbidity

Serious complications are a relatively rare occurrence in orthognathic treatment. It is a procedure with generally low morbidity, which means the risk:benefit ratio is favourable for most patients.

##### *(a) Complications including inferior nerve paraesthesia and infection*

Two of the most commonly encountered complications include damage to the inferior dental nerve (resulting in altered sensation in the lower lip/chin area) and post-operative infection. In a study of 301 patients by Kim and Park (2007), peri-operative complications were low and included: unfavourable osteotomy (3.7%), excessive bleeding (2.0%), soft tissue damage (2.0%), nerve exposure (1.3%), instrument fracture (1.0%), and tooth damage (1.0%). Teltzrow *et al.* (2005) reviewed 1264 consecutive mandibular osteotomies and reported infection (2.8%), inferior alveolar nerve damage (2.1%), re-operation due to bending or fracture of osteosynthesis materials (1.4%), bleeding complications (1.2%) and unfavourable split (0.9%). In their study of 222 patients, Borstlapet *et al.* (2004) noted that only 6% of patients had any concerns related to altered sensation in the inferior dental nerve area at 2 years post-surgery.

Two recent studies also highlighted the low prevalence of complications: Sousa and Turrini (2012) undertook a comprehensive literature review of complications in orthognathic surgery and described nerve sensory changes (12.1% of cases), infection (3.4%), fixation problems (2.5%), TMJ pain (2.1%) and unfavourable direction of fracture (1.8%). Ianettiet *al.* (2013) reviewed 3,236 patients and noted reversible sensory lip deficit in 19% of patients, but irreversible sensory deficits in only 2% of patients. Infection occurred in 2% of patients (with only 0.2% requiring any surgical intervention), unfavourable osteotomies in 1.5%, and significant bleeding in only 0.05% of patients.

Danda and Ravi (2011) undertook a meta-analysis of 8 clinical trials with 532 patients in total and noted that, for those on short term antibiotics, the infection rate was 11.2% but reduced to only 3.8% for those on a longer course of antibiotics. Hence the infection rate is very low when managed well.

#### *(b) In-patient stay*

The in-patient stay for orthognathic surgery is short. A national review of mandibular orthognathic surgery activity in the National Health Service in England over a nine year period (Moles and Cunningham, 2009) showed that the mean inpatient stay was 3.2 days and is gradually reducing. Regression analysis indicated that inpatient stays were shorter (by 0.31 days) in high volume units than low volume units (a high volume unit was defined as a unit which had done more than 90 procedures over the 9 year observation period). Over the study period there was a reduction in inpatient stay in both high and low volume units, but the rate of decrease was significantly more in high, than in low, volume units by an additional 0.03 days/year. Part of this was a consequence of the increase in the proportion of episodes for which the length of stay was less than a day. In HES year 1997, only 2.5% of episodes had a stay of one day or less whereas, by 2005, this had increased to almost 12%. Logistic regression indicated that the odds ratio of a stay of one day or less was 1.2/year, indicating a 19% annual increase in the likelihood of a patient having a 'short' stay (usually for mandibular surgery only rather than for bimaxillary surgery).

#### *(c) Stability*

Achieving good long term stability is acknowledged as one of the most important aspects of orthognathic intervention and some procedures do have poorer stability than others, hence why clinicians reserve this treatment option for those patients with large skeletal discrepancies where the percentage gain is most obvious. Proffit *et al.* (1996, 2007) have researched extensively on the stability of different orthognathic procedures and produced the widely used "Hierarchy of Stability"; this gives guidance to clinicians regarding those procedures with the best long-term stability.

The majority of procedures undertaken on a regular basis have been shown to have good or acceptable stability (Proffit *et al.*, 1996, 2007). However, Solano-Hernandez *et al.* (2013) and Greenlee *et al.* (2011) highlighted the difficulties of managing some vertical dentoskeletal problems, particularly anterior open



bites. A systematic review undertaken by Greenlee *et al.* (2011) showed that stability of anterior open bite correction was more than 75% but tentatively suggested that the correction of anterior open bites of less than 2.5mm may give similar stability when treated by orthognathic intervention or orthodontic treatment only. However, the inability to undertake controlled studies in such situations limited the conclusions which could be drawn. This finding explains why clinicians have become more cautious in recent years in managing such problems and now focus on treating those patients with significant problems and those which have the greatest functional impact.

#### 5. Treatment of obstructive sleep apnoea/hypopnoea syndrome (OSAHS)

OSAHS can be a devastating condition, not only for the affected individual but also their families. It has serious long term consequences for a patient's physiological health and their quality of life (Davey, 2003). The inability to achieve good quality sleep causes disruption of social relationships and excessive daytime sleepiness, resulting in the inability to function effectively, irritability, depression, and an increased risk of road traffic accidents (Haraldsson *et al.*, 1990; Terán-Santos *et al.*, 1999). There is also growing evidence that untreated OSAHS is associated with a range of adverse cardiovascular issues, including hypertension (Peppard *et al.*, 2000), stroke, myocardial infarction, sudden death, congestive heart failure and atrial fibrillation (Shahar *et al.*, 2001; Ng *et al.*, 2005). The role of orthognathic treatment in OSAHS is becoming better understood as the use of the technique for this condition evolves.

Vicini *et al.* (2010) demonstrated significant clinical improvements in the two assessment parameters for OSAHS following orthognathic treatment. Indeed orthognathic treatment was shown to be as effective as continuous positive airway pressure (CPAP), the gold standard treatment modality. An important additional factor is the fact that orthognathic treatment is a one off procedure for the treatment of severe OSAHS, whereas the use of CPAP requires the patient to wear an external facemask and positive pressure pump during sleep indefinitely. This equipment is expensive, cumbersome and noisy for both the patient and their partner and, as a result compliance with CPAP can be poor (Wright *et al.*, 1997; Ferguson *et al.*, 1997). Orthognathic treatment may well be a cheaper and more cost effective treatment in the longer term for severe cases, even where CPAP is tolerated.

Holty and Guilleminault (2010) performed a systematic review and meta-analysis of the literature looking specifically at maxillomandibular advancement (MMA) (ie. forward movement of both maxilla and mandible) for the treatment of OSAHS. Most subjects reported improved quality of life and improved symptoms following surgery. The mean Apnoea-Hypopnoea Index (AHI) decreased from 63.9/h to 9.5/h ( $p < 0.001$ ), with a pooled surgical success rate of 86%. Overall, 43.2% of subjects were cured (AHI  $< 5/h$ ) and long-term surgical success was maintained at a mean follow-up of 44 months.

A review article by Pirklbauer *et al.* (2011) concluded that MMA is currently the most effective craniofacial surgical technique for the treatment of OSA in adults. The procedure enlarges the pharyngeal space by expanding the skeletal framework to which the soft-tissue pharyngeal structures and tongue attach, thus resulting in reduced pharyngeal collapsibility during negative-pressure inspiration (Zinseret *et al.*, 2013).

Goodday and Bourque (2012) found that patients reported a dramatic improvement in daytime sleepiness, snoring, and witnessed apnoeas after orthognathic surgery. Additionally, the majority of patients (93-96%) were able to discontinue CPAP after their orthognathic intervention.

It is therefore appropriate to consider orthognathic intervention for some OSAHS patients.

#### **6. Treatment of Temporomandibular Joint dysfunction (TMD)**

A meta-analysis on orthognathic treatment and TMD was published in 2009 and concluded that *“although orthognathic surgery should not be advocated solely for treating TMD (temporomandibular dysfunction), patients having orthognathic treatment for dentofacial deformities and who are also suffering from TMD, appear more likely to see improvement in their signs and symptoms than deterioration”* (Al-Riyamiet *et al.*, 2009). Therefore, orthognathic treatment cannot be recommended purely for temporomandibular joint problems, but patients being treated for other functional problems may see improvements in their temporomandibular joint symptoms.

#### **7. Treatment for speech problems**

There is little reliable evidence to support the use of orthognathic treatment for the treatment of speech or articulation abnormalities.

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