



## Early Orthognathic Surgery: A Review

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### ABSTRACT

**Introduction:** Management of growing patients with severe developmental jaw abnormalities can be very difficult. Early surgical intervention may be warranted in situations where function (e.g., mastication, swallowing, breathing, or speech) and/or psychological well-being could be negatively affected. Many surgeons and orthodontists are reluctant to recommend a surgical treatment option for growing patients with severe developmental jaw abnormalities because of their age. Specific surgical procedures can be performed during growth to correct developmental jaw abnormalities with predictable results. A sound understanding of the facial growth and the effects of the surgical procedures on subsequent growth is essential when managing growing patients with severe developmental jaw abnormalities. Children with severely progressive congenital deficiencies affecting function/health should be distinguished from ones with severe developmental jaw abnormalities that can be managed later in life. In this review, we will focus on the management of growing patients with developmental jaw abnormalities who seek orthodontic treatment, rather than patients with progressive congenital deformities affecting function and/or health.

**Keywords:** Developmental abnormalities, Early orthognathic surgery, Growing patients, Growth, Jaw deformities, Orthodontic treatment, Orthognathic surgery.

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### INTRODUCTION

Growing patients who are experiencing developmental jaw abnormalities may be managed by orthopedic

therapy, through the application of orthopedic appliance forces to modulate bone growth, or by orthognathic surgery, through the surgical repositioning of jaw segments. However, the management of these patients with developmental jaw abnormalities during their growth presents a challenging problem for both orthodontists and surgeons. One of the conundrums that makes it difficult to choose a treatment modality for such problem is the patients' age because there is no absolute agreement regarding the age limits on orthopedic therapy or orthognathic surgery. Weaver et al<sup>1</sup> reported that the patient's age influences orthodontists' treatment recommendations for orthopedic therapy and orthognathic surgery.

A lot of controversy exists regarding the timing of surgical correction of dentofacial deformities. There has been a hesitation to correct developmental jaw abnormalities surgically before the completion of facial growth. Many believed that waiting for completion of growth is warranted because of two reasons: (1) The surgical procedures required for correction of the deformity may adversely affect the subsequent growth<sup>2</sup> and (2) facial growth may continue postoperatively,<sup>3-6</sup> compromising the benefits of surgery performed producing unstable results. Contradictory results both encouraging and discouraging this practice have been published in the past.<sup>7-13</sup>

Perhaps, the most compelling reason for considering early surgical correction before facial growth is complete, comes from the growing individual him/herself. Many children with severe developmental jaw abnormalities find challenges with peer acceptance since facial appearance is an important factor in determining social relationships<sup>14</sup> and has an effect on how young adolescents are perceived.<sup>15</sup> Therefore, an early surgery during growth may be warranted and should be seriously considered, to avoid any negative psychological impact.<sup>14,16,17</sup> The potential benefits of early surgical correction of severe skeletal deformities may include shorter treatment time, since there is no need for the orthopedic phase treatment<sup>18</sup> and enhanced healing potential.<sup>19</sup>

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A clear understanding of normal facial growth is very important to manage growing patients who are suffering from jaw deformities. Normal transverse facial growth is completed first.<sup>20</sup> Then, normal horizontal facial growth is completed.<sup>21-24</sup> Finally, normal vertical facial growth is done as it continues into adulthood.<sup>23,24</sup> Approximately, 98% of facial growth is usually complete in girls by age 15 and in boys by age 17 or 18.<sup>25,26</sup> On average, growth spurt peaks in girls at age 12 years and in boys at age 14 years.<sup>27</sup>

Maxillary and mandibular deformities can occur in more than one dimension since facial growth takes place in all three planes of space (transverse, horizontal, and vertical), which may require combined surgical and orthodontic correction. Prediction of growth rate and direction can be very difficult, as it usually depends on the clinician's understanding of facial growth tendencies, and subsequent growth, of the patient's anatomical facial patterns. Furthermore, gathering data pertaining to patient's medical and family history, as well as serial clinical and radiographic examinations, is helpful to recognize growth disturbances in jaw structures.

## MANDIBULAR DEVELOPMENTAL ABNORMALITIES

### Mandibular Deficiency

Growing patients with mandibular hypoplasia who are exhibiting proportionate growth between maxilla and mandible can be corrected surgically during their growth. In such growing patients, the rate of growth can be unaltered by specific surgical procedures and a proportionate maxillary and mandibular growth rate can be expected postoperatively.<sup>5,12,28</sup> On the contrary, growing patients with mandibular deficiency who exhibit disproportionate growth between maxilla and mandible where the normal maxillary growth outpaces the deficient mandibular growth leading to progressive worsening of the mandibular retrusion. In such patients, if the deformity is to be corrected during growth, mandibular retrusion can be anticipated to occur again as the maxilla will continue to grow at a normal rate, while the mandible will remain at its deficient growth rate.<sup>29</sup>

### Surgical Techniques

Using specific mandibular ramus osteotomy techniques properly can correct mandibular deficiency during growth, with predictably stable results, as long as the temporomandibular junction (TMJ) is healthy.<sup>30,31</sup> Maintaining the preoperative mandibular growth rate after the proper mandibular ramus osteotomy is an advantageous aspect of these techniques.<sup>28,29</sup> However, the direction of the mandibular growth may be affected with the final position of the proximal segment after

surgery.<sup>32</sup> An important factor that should be considered when surgically correcting mandibular deficiency is to limit the amount of mandibular advancement to <10 mm to obtain stable results.<sup>5,29</sup>

The sagittal split ramus osteotomy (SSRO) can be very challenging when performed on young patients due to the quality of their bone and the presence of unerupted molars.<sup>33</sup> That is why, some surgeons reserve this procedure for patients over the age of 12 years to avoid complications, during or after surgery that could be caused by the above-mentioned reasons.<sup>33</sup> However, some studies have reported this procedure being successfully performed on patients as young as 8.<sup>12,28</sup>

The inverted "L" osteotomy (ILO) and the vertical ramus osteotomy (VRO) can be used to advance the mandible and vertically lengthen the ramus. Bone grafting is required to control the positional orientation of the proximal segment and to fill the bony voids between segments.<sup>33</sup> Both ILO and VRO can be performed on patients of any age as long as care is taken to avoid damage to developing teeth during the placement of rigid fixation which both techniques require.<sup>33</sup> The amount of mandibular advancement possible with the VRO can be limited by the temporalis muscle and the coronoid process interference on the zygomatic arch.<sup>33</sup>

### Mandibular Excess

Growing patients suffering from mandibular hyperplasia present with protrusive mandibles resulting in class III skeletal relationship. Class III skeletal relationship could be the result of the mandible having a large size or initiating its growth from a forward position relative to the maxilla. In these situations, growing patients could have normal mandibular growth rates that will lead them to maintain the same class III jaw relationship throughout growth. Such patients can be corrected surgically during their growth, with predictably stable results, by using proper mandibular ramus osteotomy techniques without altering their maxillary and mandibular growth rates after surgery. On the contrary, growing patients with mandibular hyperplasia (class III skeletal relationship) is caused by an accelerated growth of the mandible.

The acceleration in the mandibular growth almost always takes place in the condyles (condylar hyperplasia).<sup>34,35</sup> It usually begins during the pubertal growth spurt.<sup>36</sup> It can be unilateral or bilateral and can be in a horizontal or vertical direction. A unilateral excessive growth of the mandibular condyle may result in significant dental, skeletal, and soft tissue asymmetry. In patients with condylar hyperplasia, bone scanning (Technetium 99 – a single-photon emission computed tomography scintigraphy examination) is routinely used

to evaluate the hyperactivity of the condyles, where it will show an increased uptake of radioisotope on the hyperplastic condyle.<sup>37,38</sup> However, the gold standard for diagnosing a condylar hyperplasia is to correlate the clinical findings with the bone scan.<sup>39</sup> A high condylectomy procedure has been suggested to eliminate further mandibular growth.<sup>40</sup> One of the surgical options, i.e., preferred by some surgeons<sup>33</sup> is to manage condylar hyperplasia during growth with a high condylectomy and simultaneously correcting the jaw deformity using SSRO. The SSRO procedure allows for a better control of the condyle position and maintains maximal soft tissue attachments and thus vascularity to the proximal segment minimizing any compromise to that segment.<sup>33</sup>

In addition to the previous option regarding the management of mandibular prognathism caused by condylar hyperplasia, based on the guidelines of Wolford et al,<sup>41</sup> there are two options: Either orthognathic surgery when the hyperactivity of the condyle subsides or to perform mandibular surgery during growth, after the majority of maxillary growth is complete, with overcorrection of the mandible. The accelerated growth of the mandible can be anticipated to continue after surgery, and additional surgery will be necessary if the overcorrection is insufficient or excessive.<sup>33</sup>

### *Surgical Techniques*

Using specific mandibular ramus osteotomy techniques properly can correct mandibular deficiency during growth, with predictably stable results, as long as the TMJ is healthy.<sup>30,31</sup> Maintaining the preoperative mandibular growth rate after the proper mandibular ramus osteotomy is an advantageous aspect of these techniques.<sup>28,29</sup> However, the direction of the mandibular growth may be affected with the final position of the proximal segment after surgery.<sup>32</sup>

The SSRO can be very challenging when performed on young patients due to the quality of their bone and the presence of unerupted molars.<sup>33</sup> That is why, some surgeons reserve this procedure for patients over the age of 12 years to avoid complications, during or after surgery, that could be caused by the above-mentioned reasons.<sup>33</sup> However, some studies have reported this procedure being successfully performed on patients as young as 8.<sup>12,28</sup> As mentioned above, SSRO is the procedure of choice when high condylectomy is performed simultaneously to eliminate excessive mandibular growth caused by condylar hyperplasia.

To manage mandibular prognathism, ILO and VRO can be used effectively. Both ILO and VRO can be performed on patients of any age as long as care is taken to avoid damage to developing teeth during placement of rigid fixation, which both techniques require. The amount

of mandibular set back, i.e., feasible with the VRO is limited by the temporalis muscle and the coronoid process interference on the zygomatic arch unless a coronoidectomy is performed.

High condylectomy is a surgical procedure that involves removing the superior 3 to 5 mm of the condylar head leading to an arrest in the growth of the mandible by removing the active growth center in condylar hyperplasia.<sup>40,42</sup> This procedure will not affect appositional mandibular growth and dentoalveolar growth.<sup>33</sup> Furthermore, normal TMJ function after this surgery can be anticipated to remain that way if the surgery was performed correctly.<sup>33</sup>

Application of rigid fixation with all of the mandibular SSRO, ILO, VRO techniques will improve the short- and long-term stability.<sup>43</sup> A large-sized tongue may create postsurgical relapse by causing forward posturing of the condyle in the fossa. The use of a reduction glossectomy may be indicated in specific cases.<sup>44</sup>

### **Chin Deformities**

Developmental abnormalities of the chin can occur in all three planes of space, as a result of excessive or deficient development. This could lead to height, width, and horizontal problems. Inferior border osteotomy of the mandible for chin augmentation or recontouring (genioplasty) is aimed to correct such problems and has been used widely since first reported in 1957.<sup>45</sup> It is much less invasive than mandibular ramus surgery and can improve the esthetic outcomes of comprehensive orthodontic treatment.<sup>46</sup> The optimum age for genioplasty has been controversial. However, as a guideline, the procedure can be done at any age after the eruption of mandibular canines. The presence of unerupted teeth that cannot be avoided during a lower border osteotomy in a child is a contraindication for an early genioplasty.

Several studies have shown benefits of genioplasty during growth. Severe deformities in the chin affecting young patients can cause facial appearance disfigurement, which could lead to a negative psychological impact that may warrant earlier treatment for these severely affected patients.<sup>14,16</sup> Frapier et al<sup>47,48</sup> showed that early genioplasty could improve lip function causing an improved direction of the mandibular growth as a result of increased nasal breathing. Some studies showed better healing after surgery in young patients following this type of surgery.<sup>49,50</sup> Other reports found that after genioplasty, bone remodeling of the mandibular alveolar bone above and behind the osteotomy site increased when this surgery is done in young growing patients.<sup>51-56</sup> On the contrary, there are some concerns about possible negative effects of the early surgery on growth postoperatively and decreased stability would be a major reason for waiting until little or no growth remained.<sup>55</sup>

Several studies have reported that genioplasty is the most stable of the orthognathic surgery procedures and that significant relapse is almost never observed.<sup>49,51,57,58</sup> In contrast, few reports noted some greater relapse in younger patients when compared to adults but it was neither clinically nor statistically significant.<sup>50</sup> The use of expensive bone screws may not be required for all genioplasty procedures to achieve better postsurgical stability<sup>59</sup> since it can be expected with the use of wire fixation.<sup>49</sup>

## MAXILLARY DEVELOPMENTAL ABNORMALITIES

### Maxillary Hypoplasia

Maxillary hypoplasia can occur in all three planes of space, as a result of deficient maxillary development. Early surgical correction of severe maxillary deformities may be warranted if significant functional, esthetic, and psychosocial disturbances are present. A major problem with surgical correction of horizontal maxillary deficiencies during growth is that a recurrence of the class III skeletal relationship will reoccur, as the mandible continues its normal growth rate. Hence, it is common to overcorrect the deficient maxilla since the mandible will grow normally. Parents and patients must be aware that a second surgery after growth may be necessary if the overcorrection was deficient or excessive.

#### *Correction of Horizontal and Vertical Dimension*

Le Fort I osteotomy is a common procedure, i.e., done to correct horizontal and vertical maxillary deficiency. However, it has an inhibitory effect on further anterior growth of the maxilla.<sup>9,60</sup> On the contrary, horseshoe maxillary osteotomy procedure will allow for little antero-posterior (AP) growth since the nasal septum remained attached.<sup>61</sup> In both procedures, vertical maxillary growth rate remains unaltered and resumes its same rate as before surgery.<sup>32,60,62,63</sup> In both procedures, care must be taken to avoid damaging the apices of the developing permanent teeth when placing the osteotomies and applying rigid fixation.

#### *Correction of Transverse Dimension*

The midpalatal suture can be opened with a light force delivered by a transpalatal arch during early mixed dentition. In early adolescence, a heavier force from a jackscrew is required to fracture bony interdigitations at the midpalatal suture. By late adolescence, around age 15 years, when transverse growth is complete for a while, even a heavy force from a jackscrew is unlikely to open the fused suture. Usually, when the maxillary transverse deficiency is more than 5 mm, surgical assistance may

be required for skeletally mature patients.<sup>64,65</sup> However, surgical correction of transverse maxillary deficiencies is rarely indicated before the age of 15 years. Surgically assisted rapid palatal expansion (SARPE) is a common treatment of choice to manage skeletally mature patients with transverse maxillary deficiencies to correct posterior cross bite.<sup>66,67</sup> The original rationale for SARPE was to make horizontal cuts in the lateral walls of the maxilla to reduce resistance during expansion with a jackscrew to allow the midpalatal suture to be opened. At present, SARPE has evolved to involve all Le Fort I osteotomy cuts without mobilization of the maxilla. Segmental/multipiece Le Fort I osteotomy, 2-piece or 3-piece, is also an option to correct transverse maxillary deficiencies in skeletally mature patients. However, the segmental osteotomy is shown to be unstable when more than 8 mm of maxillary expansion is done.<sup>68</sup>

### Maxillary Hyperplasia

Maxillary hyperplasia can occur in all three planes of space, as a result of excessive maxillary development. Early surgical correction of severe maxillary deformities may be warranted if significant functional, esthetic, and psychosocial disturbances are present. The excessive horizontal growth of the maxilla results in a maxillary protrusion (class II skeletal relationship). While excessive vertical growth of the maxilla results in vertical maxillary hyperplasia (vertical maxillary excess),<sup>69,70</sup> it also results in an excessive display of maxillary teeth and gingival tissue.<sup>71</sup> Patients with excessive vertical maxillary growth have been documented to have long faces that are deficient in the AP direction, along with the chin, as a result of a progressive backward rotation of the mandible and an increased mandibular plane angle.<sup>22,70,72-74</sup>

#### *Correction of Horizontal and Vertical Dimension*

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## CONCLUSION

- Growing patients with developmental jaw relationship abnormalities may benefit from early intervention with orthognathic surgery, especially with regard to their psychological well-being.
- Many factors have to be considered to reach an accurate early surgical intervention decision and outcome, such as patient's psychological state, medical and family history data, understanding of facial growth, proper execution of surgery, and TMJ health.
- Factors that may affect the stability of the surgical procedures have to be considered and addressed before surgery, such as tongue size and posture, oral habits, amount of surgical movement, and fixation technique.
- The proper surgical procedure has to be performed based on how it will address a specific developmental jaw problem in one/all plane(s) of space and on how it will affect growth amount and direction of both jaws after surgery, since different surgical techniques may affect growth differently.
- Overcorrection may be needed in the early surgical management of some developmental jaw deformities. Patients and their parents have to be aware that an additional surgery may be needed in the future.

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