Use of Iowa Spaces for the orthodontic management of mandibular postsurgical skeletal relapse

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Abstract

It has been documented that there is a tendency for skeletal relapse after orthognathic surgery. This relapse occurs more often following mandibular bilateral sagittal split osteotomy setbacks. The possible causes for lack of postsurgical stability as well as the clinical recommendations to manage the relapse are presented. Among these recommendations is the creation of Iowa Spaces.

Key words: External apical root resorption, Iowa Spaces, margin for adjustment/compensation, orthognathic surgery, skeletal relapse

INTERVIEW

1. What are Iowa Spaces and what are they used for?

Iowa Spaces are 2 mm spaces created bilaterally, distal to the maxillary lateral incisors [Figure 1].

These two maxillary spaces are purposely created, prior to orthognathic surgery, to allow the surgeon to achieve a fully seated posterior occlusion without interference by the anterior teeth [Figure 2].

During a conversation I recently had with Dr. John S. Casko, Past-Chair of the Orthodontic Department at the University of Iowa, he shared with me that in the past he had seen too many surgical orthodontic cases finished in less than a full Class I canine occlusion because it was not possible to seat the presurgical models into a full Class I due to a lack of overjet; that by advancing the maxillary incisors and leaving spaces distal to them (Iowa Spaces), it was possible to fully seat the presurgical models; and that if excess anterior overjet remained postoperatively, it only took one or two appointments to close them, as opposed to needing many more appointments to correct a slightly Class II posterior occlusion.

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2. Why these spaces are called Iowa Spaces?

Dr. Casko let me know that the term "Iowa Spaces" was coined by participants who learned about the spaces during courses given by him. He stated that it is a simple concept that became popular because it made a big improvement in the quality of the final occlusal results, which the meeting participants saw when they went back to their practices.

3. How many years of clinical experience have you had with Iowa Spaces in your office?

I started using the Iowa Spaces in my own practice over 20 years ago after hearing Dr. Casko's lecture at one of the College of Diplomates of the American Board of Orthodontics' meetings.

After a few years of using Iowa Spaces in the upper arch, it occurred to me that it would be a good idea to create Iowa

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Spaces in the lower arch in patients in whom mandibular surgical setbacks were planned [Figure 3a and b].

Figure 1: Presurgical lateral intraoral view of Patient A, who will undergo mandibular advancement surgery. Note 2 mm Iowa Space created distal to the maxillary right lateral incisor. Not able to be observed in this view is another Iowa Space on the opposite side, distal to the maxillary left lateral incisor. These two Iowa Spaces facilitate a fully seated posterior occlusion during surgery

Figure 2: Immediate postsurgery lateral cephalogram of Patient B following combined surgery (mandibular surgical set-back and maxillary surgical advancement). At this time, the patient still has the 2 mm maxillary Iowa Spaces present, creating a temporary anterior overjet, which allowed a fully seated posterior occlusion during surgery, without interference by the anterior teeth

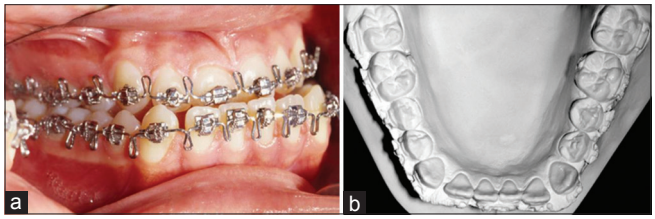

Figure 3: (a) Presurgical lateral intraoral view of Patient C with bilateral 2 mm Iowa Spaces created distal to the mandibular lateral incisors. This patient will undergo mandibular surgical set-back combined with maxillary surgical advancement. (b) Presurgical occlusal view of Patient C's mandibular dental cast. Note bilateral 2 mm Iowa Spaces distal to the mandibular lateral incisors

These mandibular Iowa Spaces provide a margin for adjustment to compensate a possible postsurgical skeletal mandibular relapse in a forward direction, which frequently occurs following mandibular surgical setbacks using the bilateral sagittal split osteotomy (BSSO) procedure.

Proffit *et al.*[1] reported that in one-fourth of the patients who received wire fixation and in nearly half of the patients who received rigid internal fixation, the chin moved forward more than 4 mm following mandibular surgical setback using BSSO.

4. What is the evidence that postorthognathic surgical skeletal relapse occurs?

It has been documented that there is a higher tendency for skeletal relapse following orthognathic surgery of certain surgical procedures. Proffit *et al.*[2] ranked the various types of orthognathic surgical movements according to their postsurgical predictability and stability, i.e., a hierarchy of surgical procedures according to their predictability/stability. These authors grouped the relapse tendency into four categories: (1) Highly stable, (2) Stable, (3) Stable if rigid internal fixation is used, and (4) Problematic, defined as 40–50% of chance of having 2–4 mm postsurgical change, and a significant chance of having a >4 mm relapse.

They derived the predictability/stability hierarchy data from the University of North Carolina Dentofacial Program database, which by the year 2004[3] contained over 3000 initial records of nonsyndromic patients, and over 1400 patients with at least 1 year follow-up, treated with maxillary and/or mandibular orthognathic procedures to correct developmental deformities.

These researchers found that the surgical procedures to correct Class II problems (maxilla up, mandible forward, and the combination of the two procedures) are more predictable and stable than the procedures for Class III problems (maxilla forward, maxilla forward plus mandible back, mandible back, and maxilla down).[4]

BSSO is widely used for mandibular surgical setbacks due to many advantages it provides (the mandible can be moved forward or backward, the distal segment can be rotated down anteriorly when additional face height is desired, rigid internal fixation can be used thus requiring no maxillo-mandibular immobilization, and excellent bone-to-bone contact occurs minimizing healing problems). In spite of the many advantages that the BSSO procedure provides, it unfortunately falls into the problematic category because of its high tendency to relapse in a forward direction.

Figure 4a and b of Patient D serve to illustrate that mandibular postsurgical skeletal forward relapse does indeed occur. Patient D's cephalometric superimposition of the presurgical cephalometric tracing, age 14–8, and the immediate postsurgical cephalometric tracing, age 14–11 [Figure 4a], demonstrate the changes that occurred due to the triple jaw surgery (maxilla up and forward, mandible back, and chin up and forward) undergone by this patient. The objectives were to correct this patient's long face, to increase the midfacial anteroposterior deficiency, and to correct the mandibular prognathism [Figure 4c].

Patient D's cephalometric superimposition of the immediate postsurgical cephalometric tracing, age 14–11, and the long-term follow-up cephalometric tracing, age 21–2 [Figure 4b], demonstrates that the mandible relapsed 3 mm forward. The patient and the orthodontist were fortunate that postsurgery the maxillary incisors also moved 3 mm forward autonomously, compensating the skeletal relapse. It is interesting to observe that the ramus inclination was increased during surgery [yellow arrow in Figure 4a]. This increase in the ramus inclination could be one of the reasons for a mandibular forward relapse, a topic that will be addressed in the interview question number 5.

Patient D's presurgical facial profile photograph can be seen in Figure 4c. A long face, a midfacial anteroposterior deficiency, and a mandibular prognathism can be observed. The patient will undergo triple jaw surgery.

Figure 4d shows Patient D's immediate postsurgical facial profile photograph. Note dramatic improvement due to the surgery. The maxilla was moved up and forward, the mandible back, and the chin up and forward.

The semi-transparent superimposition of the presurgery facial profile photograph with the immediate postsurgery facial profile photograph demonstrates the dramatic facial change that occurred due to the surgery [Figure 4e].

Figure 4f exhibits Patient D's 1 year and 2 months postsurgical facial profile photograph. Note that the upper lip has moved forward as the upper incisors tipped forward, compensating a postsurgical mandibular forward relapse, resulting in a diminished nasolabial angle.

Figure 4g shows Patient D's facial profile photograph 6 years postsurgery. A pleasing profile can still be observed.

However, the semi-transparent superimposition of the immediate postsurgery facial profile photograph with the 6-year postsurgery facial profile photograph [Figure 4h] demonstrates the magnitude of mandibular forward relapse that occurred, which fortunately was compensated by the maxillary incisors moving forward, as well as the upper lip.

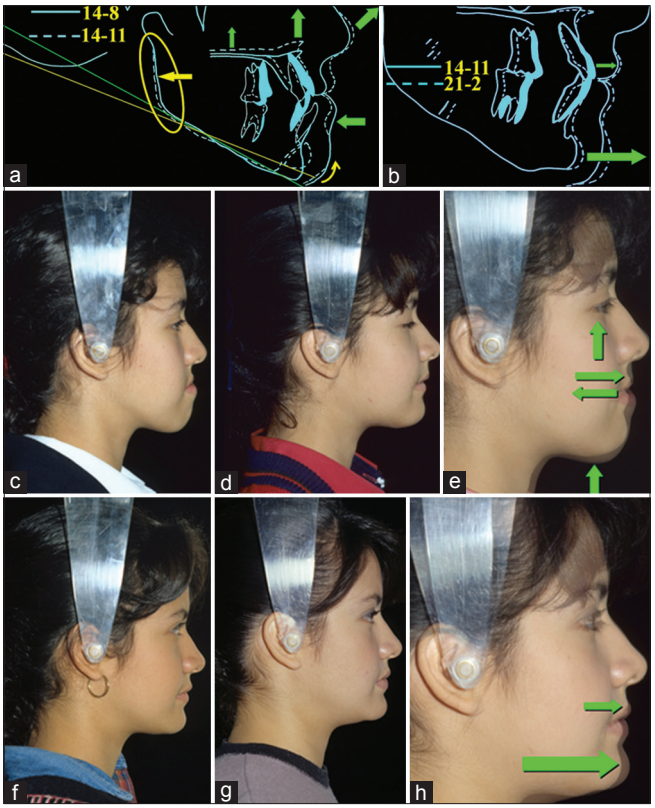

Figure 4: (a) Patient D's cephalometric superimposition of the presurgery tracing (age 14–8), and the immediate postsurgery tracing (age 14–11). Patient underwent triple jaw surgery (maxilla up and forward, mandible back, and chin up and forward) to correct the long face, the midfacial anteroposterior deficiency, and the mandibular prognathism. The green arrows indicate the direction of the surgical movements. Mandibular plane was reduced 8° in the direction indicated by the curved yellow arrow. Note that the mandibular ramus was pushed back during surgery (straight yellow arrow), which could potentially lead to a postsurgical mandibular forward relapse. (b) Patient D's cephalometric superimposition of the immediate postsurgery tracing (age 14–11), and the 6-year postsurgery tracing (age 21–2). The patient underwent triple jaw surgery during which the mandibular ramus was pushed back (increased ramus inclination). Note that postsurgery the mandible relapsed forward 3 mm (large green arrow). The maxillary incisors autonomously moved forward 3 mm (small green arrow), thereby compensating the mandibular relapse. The upper lip also moved forward resulting in a diminished nasolabial angle. The patient's surgery took place 3 years postmenarche, so the relapse cannot be attributed to growth. Note additionally that no vertical growth occurred, further suggesting that the relapse was probably not due to growth. (c) Patient D's presurgery facial profile photograph (age 14–8). Note long face, midfacial anteroposterior deficiency, and mandibular prognathism. The patient will undergo triple jaw surgery. (d) Patient D's immediate postsurgery facial profile photograph (age 14–11). Note dramatic facial improvement. (e) Patient D's semi-transparent superimposition of presurgery facial profile photograph (age 14–8) and immediate postsurgery profile facial photo (age 14–11). The arrows indicate the direction the jaws were moved during surgery. Note dramatic facial change. (f) Patient D's 1 year 2 months postsurgical facial profile photograph (age 16–0). Note that the upper lip has moved forward as the upper incisors tipped forward, compensating a postsurgical mandibular forward relapse, resulting in a more acute nasolabial angle. (g) Patient D's 6 year 2 months postsurgery facial profile photograph (age 21–2). Note pleasing profile was maintained in spite of the mandibular forward relapse. (h) Patient D's semi-transparent superimposition of immediate postsurgery facial profile photograph (age 14–11) and 6 years 2 months postsurgery facial profile photograph (age 21–2). Note facial change due to mandibular forward relapse

In Patient D, no Iowa Spaces were created because at the time the author treated this patient, he was not aware of the advantages of creating these spaces. Thus, no margin for adjustment to compensate for relapse was incorporated presurgery. Had mandibular Iowa Spaces been created (prior to orthognathic surgery), the surgeon would have been obligated to fixate the mandibular distal segment (mandibular body) further back. This would have been advantageous from the standpoint of the final treatment result because if the mandible was to relapse forward postsurgically (as occurred in Patient D, and occurs in one-fourth of the patients who receive wire fixation and in nearly half of the patients who receive rigid internal fixation),[1] the orthodontist would have been able to compensate this undesired skeletal movement by closing the Iowa Spaces, moving the lower incisors lingually. On the other hand, if no skeletal relapse would have occurred, the orthodontist could have closed the Iowa Spaces by moving the posterior teeth forward, as illustrated in Figure 5a.

Thus, mandibular Iowa Spaces give the orthodontist a mechanism through which he/she can, fully or partially, compensate the mandibular forward skeletal relapse by moving the lower incisors back into these spaces. Mandibular Iowa Spaces provide a "margin for adjustment" following mandibular surgical setbacks [Figures 3a, b and 5a, b].

Figure 5c shows Patient C's surgical movements carried out during the orthognathic procedure (maxillary surgical advancement and mandibular surgical setback). The superimposition corresponds to the presurgery cephalometric tracing (age 15–0) and the immediate postsurgery cephalometric tracing (age 15–4). Note that the inclination of the mandibular ramus was not pushed back (was not increased). In spite of this, mandibular skeletal relapse occurred; Figure 5a demonstrates this relapse.

5. *What causes the lack of stability following mandibular surgical setback when using BSSO?*

Proffit *et al.*[4] found that postsurgical mandibular forward movement (relapse) is frequently due to the inadequate surgical management of the proximal segment (mandibular ramus) at the time of surgery. They found that if the ramus is pushed back at surgery, the mandibular muscle sling almost always moves it forward to its original inclination during the first postsurgical year, and that the more firmly the ramus is fixed to the body postsurgically (e.g., rigid internal fixation), the greater the likelihood that the chin also will go forward when the ramus uprights. The authors state that this skeletal mandibular relapse occurs after maxillo-mandibular fixation is released and function is resumed.

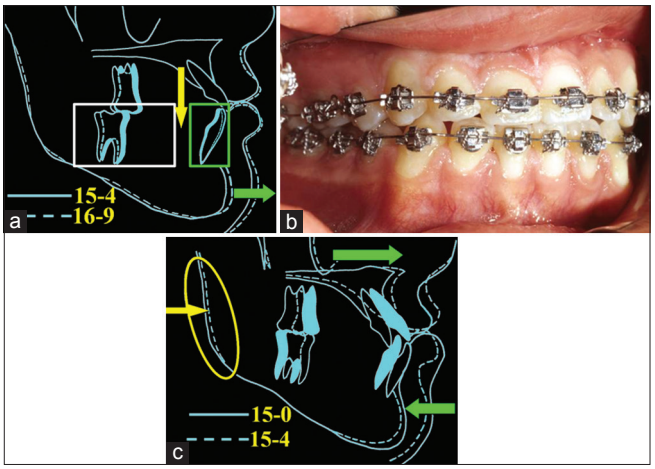

Figure 5: (a) Cephalometric illustration of mandibular Iowa Spaces as a method to compensate for mandibular postsurgical forward relapse. Note that the mandible did indeed relapse forward postsurgery (green arrow), as can be observed in Patient C's cephalometric superimposition (immediate postsurgery cephalometric tracing, at age 15–4, and cephalometric tracing 15 months postsurgery, at age 16–9). In spite of the mandibular forward skeletal relapse, the orthodontist was able to compensate this undesirable outcome by moving the lower incisors toward the lingual using the mandibular Iowa Spaces (yellow arrow). Teeth inside the white box (canines to molars) correspond to the posterior dental segments, and teeth inside the green box (4 incisors) correspond to the anterior dental segment. (b) Patient C's mandibular Iowa Spaces [Figure 3a and b] have been closed by moving the incisors lingually, since a mandibular postsurgical forward relapse occurred, as evidenced by the cephalometric superimposition in Figure 5a. (c) Patient C's cephalometric superimposition shows the changes that occurred during a combined maxillary surgical advancement and a mandibular surgical set-back (green arrows). The presurgical cephalometric tracing corresponds to age 15–0 and the postsurgical cephalometric tracing corresponds to age 15–4. Note that the surgeon did not push the mandibular ramus back; in fact, it is further forward (yellow arrow). In spite of this, a mandibular skeletal relapse occurred, as demonstrated in Figure 5a

Figure 4a illustrates this phenomenon very clearly. Note that the mandibular ramus was indeed pushed back (is now more vertical) which could lead to a mandibular postsurgical forward relapse, which in this Patient D did in fact occur.

Another possibility of forward movement of the chin postsurgically, mentioned by Proffit *et al.*,[1] is an adjustment of condyle–fossa relationships as a correction for condyles that were retropositioned at surgery.

Taking into account the above information, it is proposed that the creation of presurgical mandibular Iowa Spaces allows the orthodontist to compensate, partially or fully, for both causes of postsurgical mandibular forward relapse (ramus inclination pushed back and/or retropositioned condyles).

6. *What other procedures do you use, in addition to creating mandibular Iowa Spaces, to counter or manage the tendency for skeletal relapse in*

patients who undergo BSSO to correct mandibular prognathism?

Based on the information presented in the previous section, it is important to recommend to the surgeon that he/she should not increase the ramus inclination during surgery.

The additional procedures I recommend to improve postsurgical stability, following mandibular setback, are the following:

- Have the patient use an extra-oral traction appliance (chin-cup) postsurgically to attempt to maintain the corrected skeletal relationships while the mandibular muscle sling adapts to the new position. The chin-cup appliance should be used 10–14 h per day the first 3 months following surgery and then another 3 months nights-only. Perhaps, this appliance should not be used if the patient undergoes simultaneous genioplasty due to the pressure exerted by the chin-cup against the recently surgerized chin
- Postpone surgery until it can be documented that the patient's growth has ceased (e.g., by superimposing two successive lateral cephalometric head films separated by 1 year) and,
- Recommend surgical procedures that provide greater stability, for example, using combined maxillo-mandibular surgeries, where possible, to reduce the magnitude of the mandibular surgical setback.

7. What would you recommend as a routine protocol for the creation of Iowa Spaces in preparation for orthognathic surgery?

- If the patient has pretreatment dental spacing, I would recommend closing all spaces in three separate segments, i.e., close all spaces in the posterior segments (from canines to molars) and close all spaces in the anterior segment (from lateral incisor to lateral incisor), leaving 2 mm spaces distal to the lateral incisors. In mandibular surgical setbacks, the Iowa Spaces should be created in the lower arch [Figures 3a, b and 5a]; in mandibular surgical advancements, the Iowa Spaces should be created in the upper arch [Figure 1]
- If the patient has no dental spacing and will need bicuspid extractions, I would recommend closing the extraction spaces partially, leaving 2 mm spaces, but transferring these to the distal of the lateral incisors
- If the patient does not need bicuspid extractions but has no spacing, I recommend using bilateral compressed open coil springs placed between canines and lateral incisors to create the Iowa Spaces, taking care that these four teeth do not rotate due to the activated coil springs. This means using a full-sized wire to prevent these rotations from occurring while the spaces are being created. Iowa Spaces, once created, should be maintained open with closed coil springs.

8. At what point in treatment would you recommend closing the Iowa Spaces?

I recommend maintaining the Iowa Spaces a minimum of 3 months postsurgery. This period allows the orthodontist to assess whether skeletal relapse is occurring. The Iowa Spaces can then be closed either by moving the anterior segment toward the lingual or the posterior segments toward the mesial, depending on the direction and magnitude of the mandibular skeletal relapse [Figures 3a, b and 5a, b].

9. What problems have you encountered with the Iowa Spaces?

The only problem I have encountered with Iowa Spaces is the tendency of the canines to rotate toward the distal when using compressed open coil springs to create these spaces. That is the reason why I recommend opening the Iowa Spaces only until a full-sized SS wire can be tied in to all the brackets.

10. Why should orthodontists consider orthognathic surgery as a root sparing treatment regime?

In the litigious environment in which we live today, it is very important to prevent iatrogenic problems from developing. Orthognathic surgery should be considered a root sparing treatment regime, since the orthodontic movements required prior to surgery are decompensatory, meaning that they do not move roots toward cortical bone.

Unfortunately, the current trend in the orthodontic world is to avoid orthognathic surgery, partly because insurance companies often refuse to pay for these procedures. This trend puts patients at an increased risk of external apical root resorption (EARR). Orthodontic treatment without orthognathic surgery, in patients for whom surgery is indicated, obligates the orthodontist to move tooth apices large distances, which is a treatment-related risk factor for EARR.[5-16] Moving apices large distances increases treatment duration, which is also a treatment-related risk factor for EARR.[7-12] Both of these factors, plus root proximity to cortical plates,[6,17,18] create a higher risk of EARR development.

A patient presented in Chapter 2 of a book I recently published (titled "Iatrogenic Effects of Orthodontic Treatment: Decision-Making in Prevention, Diagnosis and Treatment")[19] serves as an example of the use of

orthognathic surgery to avoid overcompensating tooth positions, which may lead to EARR. The best EARR prevention measure is not to treat patients who require orthognathic surgery, but who refuse to undergo surgery.

CONCLUSION

Orthodontists and maxillofacial surgeons are highly trained dental caregivers obligated to abide by the Hippocratic Oath of doing no harm. It is my hope that this interview, on the use of Iowa Spaces, will make clinicians aware that the creation of these Spaces, prior to orthognathic surgery, is a valuable aid in the management of mandibular skeletal relapse.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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