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Int J Adult Orthod Orthognath Surg
Vol. 16, No. 2, 2001

Complications following orthognathic surgery that required early surgical intervention: Fifteen years' experience

The aim of this study was to assess complications following various orthognathic surgical procedures that required early surgical intervention. This study was carried out on 821 patients who had undergone surgical treatment for correction of dentofacial deformities between 1985 and 2000. Only patients who required a second procedure to deal with immediate or early postoperative complications (ie, those occurring within 4 weeks of surgery) were investigated in this study. Twelve patients underwent a second surgical procedure; 9 had undergone conventional osteotomy surgery, and 3 had undergone distraction osteogenesis. Three Le Fort I cases had to be further impacted and repositioned, and 4 vertical subsigmoid osteotomies had to be reexplored. The details of the complications are presented, and possible methods by which these problems could be reduced and/or prevented are discussed. (Int J Adult Orthod Orthognath Surg 2001;16:138–144)

Orthognathic correction of dentofacial and craniofacial deformities has come a long way since its invention at the end of the 19th century. Advances in anesthesia, neurosurgery, maxillofacial surgery, and critical care have made it possible to correct facial deformities that in the not-too-distant past were considered untreatable. The Le Fort I osteotomy and mandibular ramus surgery (including both the sagittal split ramus osteotomy and the vertical ramus osteotomy, with or without genioplasties) are the most frequently used methods for correction of dentofacial deformities. Although a large number of studies have been carried out to evaluate the relapse rate following these procedures,[1–7] there are few articles in the literature that focus on postoperative complications. The most frequently mentioned are lesions of the inferior dental nerve,[8–11] fractures of the mandibular proximal segment,[12,13] incomplete sectioning,[9,13,14] malpositioning of segments,[14,15] and severe hemorrhage.[5,11,13,16–18]

There are relatively few reports concerning intraoperative complications relating to mandibular osteotomies,[2,6,19,20–22] some of which required a second surgical intervention. We report in this study our last 15 years' experience of immediate and early postoperative complications that required a second surgical procedure in patients who had undergone orthognathic surgery.

The aims of this study were twofold:

1. To assess the complications that required early surgical intervention following various orthognathic surgical procedures.
2. To investigate the causes of these complications and the possibility of their prevention.

Materials and methods

This study was carried out on all patients who had undergone surgical treatment for

correction of dentofacial deformities between January 1985 and January 2000 at Canniesburn Hospital at the West of Scotland Regional Maxillofacial Unit. Only patients who required a second procedure to deal with immediate or early postoperative complications (ie, those occurring within 4 weeks of surgery) were investigated in this study. The case notes and radiographs of these patients were reviewed, and the following parameters were investigated: preoperative diagnosis, operative procedure, postoperative complications, the interval between the 2 surgical procedures, and the type of secondary surgery performed.

Results

A total of 821 patients who had undergone orthognathic surgery during the last 15 years were identified. The age of patients ranged from 13 to 44 years, with a mean of 27 years. Twelve patients returned to the operating room within 1 month of the initial surgical procedure for the correction of their deformity (Table 1). The patients can be grouped into those who had conventional osteotomy surgery (n = 9) and those who received distraction osteogenesis (n = 3). Among the osteotomy patients, there were 7 bimaxillary cases, 3 of which were Le Fort I osteotomies that had to be further impacted and repositioned and 4 of which were vertical subsigmoid osteotomies that had to be reexplored. In 3 of the vertical subsigmoid patients, the proximal fragments were incorrectly placed and had to be repositioned (Figs 1a and 1b), and in 1 patient the proximal fragments on both sides were laterally displaced and very prominent and needed to be trimmed. One bilateral sagittal split osteotomy was incorrectly positioned, which required removal of screws and repositioning of the segments. In addition, a single-jaw surgery patient who had bilateral body ostectomies had the distal fragment incorrectly positioned in the splint anteriorly; this needed to be repositioned.

With respect to the 3 distraction patients, all were early cases in our experience. One was our first case of distraction of the mandibular ramus using an external apparatus on a hemifacial microsomia patient. Here, the cuts were made inadequately and did not reach the posterior border of the mandible, so that distraction proceeded in the anterior part of the ramus but not posteriorly. This was recognized and required further surgery to effect the appropriate movement (Figs 2a and 2b). There were also 2 Le Fort I cases. Both patients had severe bilateral cleft deformities in which there was a large discrepancy in an anteroposterior direction that could not be treated easily by conventional osteotomy surgery, especially as they had undergone extensive previous surgery. In both cases these failed because of problems with cranial fixation using a modified halo frame and pins; in one case there was a complete lack of patient cooperation and in the other the frame became loose and had to be readjusted under general anesthesia.

Discussion

Although in the past (during the late 1970s and early 1980s), 2 patients had received a second emergency surgery because of excessive bleeding (1 from a genioplasty and the other from a Le Fort III osteotomy), in this cohort, no patients required emergency surgery. All patients who required further surgery were treated within a period of 2 to 21 days. The majority of cases had bimaxillary surgery, the most commonly performed operation. The most frequent of the combined procedures that were carried out were the Le Fort I osteotomy and the vertical subsigmoid setback osteotomy. The bilateral sagittal split osteotomy tended to be reserved mostly for patients with mandibular retrusion, with only a few cases of mandibular setback for mandibular prognathism. The mandibular body ostectomy is not a commonly undertaken procedure, but in our experience over many years, only 1 patient required repositioning because of inaccurate placement of the anterior segment (distal) in a cast silver cap splint.

Distraction osteogenesis has been carried out in our facility only since late 1994. There was a definite learning curve encountered with the procedure, but with mandibular surgery only 1 patient required a second surgery. In the patient

Table 1 Summary of complications and their treatment

Patient	Sex	Date of birth (m/d/y)	Diagnosis	Surgical procedure	Date of first surgery (m/d/y)	Complication	Date of second surgery (m/d/y)	Second surgical procedure	Days inter ops	Follow-up
CB	F	11/25/61	Vertical maxillary excess, narrow maxilla, mandibular protrusion, and progenia	Bimaxillary: Le Fort I advancement and anterior setdown with posterior rise; bilateral sagittal split advancement; genioplasty setback	6/12/92	Anterior open bite from condylar distraction (posterior maxillary excess)	6/18/92	Revised Le Fort I posterior impaction and redid genioplasty	6	At 1 year, slight mandibular relapse, but acceptable
PC	F	9/25/52	Maxillary hypoplasia, (retrusion) asymmetry, prognathism, macrogenia	Le Fort I—2 piece advancement; asymmetric VSS osteotomy; anterior mandible segment setdown	3/11/94	Malposition of left VSS (occlusal discrepancy)	3/29/94	Repositioned left condylar segment (proximal segment of VSS) and trimmed	8	Stable result as of 11/30/94 (still OK)
GE	M	7/1/75	Bilateral 2-degree cleft deformity, gross maxillary hypoplasia—no pre-maxilla (failed osteotomy) (drug addict/prisoner)	1) Distraction osteogenesis Le Fort I advancement/setdown	10/12/98	Mechanical problems, splint off	11/2/98	2) Wired splints in maxilla and remanipulated the whole segment	21	Complete failure, no cooperation, no long-term advancement achieved
				3) Redid osteotomy; rewired (failed to progress)	11/27/98	Mobile Le Fort I after trauma to midface	1/22/99		(57)	
TG	F	4/30/69	Maxillary hypoplasia, mandibular prognathism, macrogenia (increased lower face height)	Bimaxillary surgery: high Le Fort I advancement; bilateral VSS setback; genioplasty—vertical reduction and advancement	11/9/90	Left proximal segment kicked back, lying lateral; occlusal discrepancy; lateral open bite	11/13/90	Reduced left proximal segment/sigmoid notch and coronoidectomy	2	Stable at 5 years
GL	F	7/21/81	Hemifacial microsomia, mandibular asymmetry, small right side	Distraction osteogenesis (corticotomy) of right mandible—ramus	12/20/94	Failed to complete cuts in ramus	1/9/96	Redid posterior cuts	20	Excellent result, stable
SMc	M	3/11/74	Bilateral 2-degree cleft deformity, collapse of lesser segments in previous premaxillary osteotomy, vertical maxillary deficiency	Le Fort I distraction osteogenesis; splints to halo fixation; vertical and horizontal advancement	5/27/99	Failed pins and loose halo	6/7/99	Repositioned and fixed; later, redid Le Fort I and bone graft (2/18/00)	10	Late adequate result
JMc	F	1/30/68	Asymmetric maxillary hypoplasia, asymmetric mandibular prognathism, retrogenia, anterior open bite	Le Fort I advancement and impaction shift to right; asymmetric mandibular VSS setback; advancement/vertical reduction genioplasty	8/11/95	Occlusal discrepancy of maxilla to the right, anterior open bite	8/30/95	Repositioned maxilla at correct cant and repositioned VSS	19	Stable, good late result, very slight anterior open bite
AM	F	8/17/66	Maxillary retrusion and vertical deficiency (flared alar bases), mandibular prognathism and progenia, slight asymmetry	Le Fort I—3 part advancement and inferior reposition of the mandible (setback); bilateral sagittal split genioplasty setback	7/15/88	Incorrect mandibular setback; malocclusion and anterior open bite (excessive on the left)	7/29/88	Redid mandibular setback, screws repositioned and maxillo-mandibular fixation; late relapse in 1993—redid 2-part Le Fort I	14	Stable after third operation
LQ	F	3/10/56	Vertical maxillary excess, deep anterior occlusion, mandibular retrusion, retrogenia	Le Fort I and impaction anterior > posterior, augmentation genioplasty, titanium mesh fixation	5/23/90	Le Fort I: insufficient bone removed posteriorly (condyles out of fossae)	5/30/90	Redid Le Fort I, posterior rise-plated	7	Good long-term stable result
FS-Q	F	1/12/64	Maxillary retrusion and posterior vertical maxillary excess, mandibular prognathism, asymmetry and macrogenia, anterior open bite	Le Fort I advancement, posterior impaction: anterior downgraft, VSS setback, vertical reduction and setback, genioplasty	12/18/98	Very prominent angles of proximal fragments	1/6/99	Smoothed proximal fragments to fit, repositioning plus maxillo-mandibular fixation	19	Slight anterior open bite relapse
LS	F	7/26/71	Maxillary retrusion and vertical maxillary excess, mandibular prognathism, anterior open bite	Le Fort I rise/advancement VSS setback, genioplasty, vertical reduction setback	1/21/90	Left proximal fragment posteriorly displaced, occlusal discrepancy	1/26/90	Left proximal fragment of VSS trimmed and repositioned	5	Stable, OK at 5 years
PW	F	6/20/65	Mandibular prognathism, asymmetric progenia and macrogenia left side, crossbite	Asymmetric mandibular setback, genioplasty to right	3/9/88	Inadequate correction	9/5/90	Bilateral body ostectomy and genioplasty to right with bone grafting	(2½ years)	Stable after 1997
				Readjust anterior segment, proplast genioplasty	9/7/90	Segment not in splint			2	

VSS = vertical subsigmoid segment

Fig 1a Immediate postoperative radiograph showing lateral and inferior displacement of the condylar segment following vertical subsigmoid osteotomy.

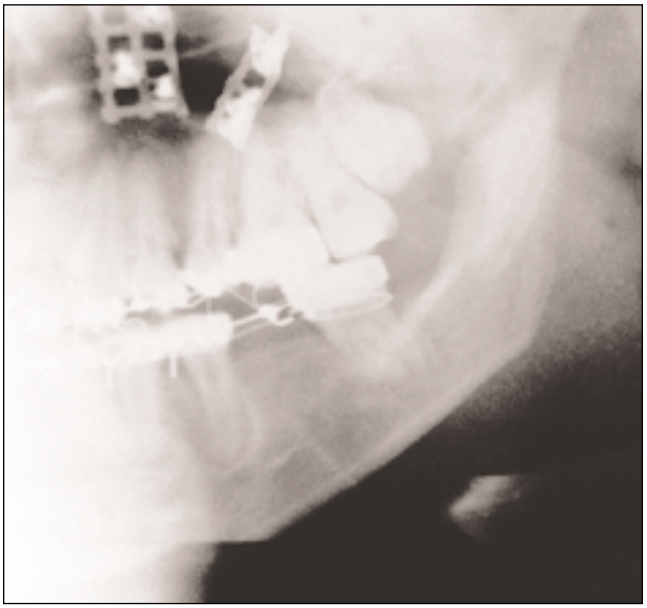

Fig 1b Radiographic appearance of the same patient following trimming of the inferior tip and suturing of the condylar segment to the ramus of the mandible.

Fig 2a Incomplete osteotomy of the posterior border of the mandible following distraction osteogenesis, which required a second surgical intervention.

Fig 2b Radiograph of the same patient showing successful lengthening of the ramus following this intervention.

who underwent midface surgery, there were clearly problems with our distraction device, which was locally developed. However, more recently, apparatus problems have proven to be much less troublesome.

Twelve patients, who constituted approximately 1.5% of the total number of patients treated, had to undergo a second surgical procedure as a result of early postoperative complications. All of these patients had their second surgery within 4 weeks of the date of their initial surgery. Seventy-five percent of the patients presented with a malocclusion as a result of either improper positioning of the maxilla or the mandible, and the other 25% included the distraction cases and 1 vertical subsigmoid osteotomy that simply required the trimming of both proximal fragments because of their prominence. With respect to the vertical subsigmoid osteotomies, 3 of the 4 patients showed improper positioning of the proximal segment on one side, usually into a posterior position. One of the osteotomy patients had had previous early surgery, and 1 bimaxillary patient required further surgery some 5 years later. One maxillary distraction patient (drug addict) was lost to follow-up and did not wish to proceed with further surgery, and the other early failed maxillary distraction patient had a further Le Fort I osteotomy and bone grafting about 8 months later. Failure to adequately raise the maxilla in anterior open bite patients, or where there was vertical maxillary excess, was sometimes a problem, as were posterior displacements of the proximal fragment in the vertical subsigmoid osteotomy.

Correction of mandibular prognathism by extraoral oblique osteotomy was first reported by Robinson[23] in 1956 and Hinds[24] in 1957. The technique has been characterized as a simple approach that provides adequate visibility of the operative field. However, damage to the facial nerve and scar formation were the basic complications of the extraoral approach to the ramus. In 1963 Moose[1] described a subcondylar osteotomy from the medial side of the mandibular ramus. The procedure had several disadvantages. Patients with a divergent mandibular ramus were difficult to operate on because of poor visibility and poor access to the sigmoid notch. This approach also carried the risk of anesthesia or paresthesias as a result of trauma to the inferior alveolar nerve. In 1968 Winstanley[25] described an intraoral subcondylar approach to the lateral aspect of the ramus, with use of a long-shank rotary bur. He reported that this approach was more difficult to perform than an extraoral approach.

To improve visibility, access, and instrumentation of the intraoral ramus osteotomy, several authors recommended the use of the Stryker oscillating saw with an angled blade, in addition to a specially designed posterior border retractor (Le Vasseur-Merrill).[27] A fiberoptic light, either on the mandibular retractor or on a suction tip, was also advocated.[27]

To promote early union between the condylar segment and the rest of the ramus, Caldwell and Letterman[26] recommended decortication of the lateral surface of the ramus, fixation with direct wiring, and drilling holes. Hall et al[27] found that in cases where the condylar segment was left free, some degree of condylar "sag" (anterior-inferior displacement) occurred. Some of these required condylar segment repositioning and wiring. They also observed that open bite secondary to intraoral vertical subsigmoid osteotomy occurred about twice as often in patients without wire fixation of the condylar segments, versus patients who received fixation. In their study, no open bites occurred following the adoption of the circumramus wiring technique after the ramus osteotomy.

To minimize postoperative condylar sag, Hall et al[27] recommended limited stripping of the medial pterygoid muscle attachment, explaining that an osteotomy that was too near the posterior border of the vertical ramus would leave a small mass of muscle attached to the proximal segment, which might result in more sag. On the other hand, in a national survey of intraoral vertical subsigmoid osteotomies, 73% of respondents left the proximal segment unfixed. Of those who used fixation, more preferred transosseous to circumramus wire.[23]

In our patients, the proximal segments were not wired to the distal segments following the vertical subsigmoid segment osteotomy. Only 4 patients showed radiographic evidence of lateral displacement

and significant condylar sag. Suturing of the condylar segment with a resorbable material to the periosteal covering overlying the distal segment was sufficient to control condylar positioning. We would recommend temporary immobilization of the proximal segment to the ramus of the mandible. Condylar sagging and lateral or medial displacement of the condylar segment were unpredictable. The position of the proximal segment intraoperatively may be altered immediately following surgery, mainly as a result of changes in the patient's posture, changes in muscle tone, and reattachment of soft tissues to the proximal segment. The amount of condylar sag is a function of the laxity of the soft tissue attached to the proximal segment, including the medial pterygoid muscle. Therefore, we would recommend minimal stripping of the medial pterygoid muscle attachment, just enough to allow the mandibular setback. Wiring of the proximal segment to the ramus of the mandible is a controversial issue, and until a prospective randomized trial is undertaken to assess its effect on mandibular stability, it would be difficult on a scientific basis to recommend one technique over another.

With regard to some of the other complications that occurred in our case series, there is no doubt that it is difficult to raise the maxilla in the Le Fort I osteotomy for the correction of posterior maxillary excess. There is a tendency to "under-do" this and in the process distract the mandibular condyles out of their fossae. Cases in which this occurred partially reflected the inexperience of those carrying out the surgery. Very careful assessment of this operation is essential and can be helped by the use of thin occlusal acrylic wafers that have been accurately constructed preoperatively using anatomic articulation. It is also important during the testing of the occlusion that there is no tendency to tip the chin forward and distract the condyles; upward pressure in the angle regions of the mandible to maintain the condyles in the fossae when undertaking this rotation should prevent this complication.

As far as distraction osteogenesis is concerned, we have reported elsewhere the problems associated with this technique.[29] There is a learning curve associated with the procedures, and with the development of working protocols, the complications associated with this surgery will be reduced. Much work is also proceeding with the development of new distraction devices, and these will no doubt become more reliable over a period of time.

This audit of complications necessitating a second surgical intervention has proved instructive to us and should reduce problems for patients related to lack of surgical experience and the expense to our Health Service.

References

1. Moose SM. Surgical correction of mandibular prognathism by intraoral subcondylar osteotomy. Br J Oral Surg 1963;1:172–176.
2. Moser L, Freihofer HP. Long-term experience with simultaneous movement of the upper and lower jaw. J Maxillofac Surg 1980;8:271–277.
3. Proffit WR, Philips C, Dann C, Turvey TA. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. I. Mandibular setback. Int J Adult Orthod Orthognath Surg 1991;6:7–18.
4. Proffit WR, Philips C, Prewitt JW, Turvey TA. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. II. Maxillary advancement. Int J Adult Orthod Orthognath Surg 1991; 6:71–80.
5. Proffit WR, Philips C, Turvey TA. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. III. Combined maxillary and mandibular procedures. Int J Adult Orthod Orthognath Surg 1991;6:211–225.
6. Stella JP, Astrand P. Patterns and etiology of relapse after correction of Class III open bite via subcondylar ramus osteotomy. Int J Adult Orthod Orthognath Surg 1986;1:91–99.
7. Hiranaka DK, Kelly JP. Stability of simultaneous orthognathic surgery on the maxilla and mandible: A computer-assisted cephalometric study. Int J Adult Orthod Orthognath Surg 1987; 2:193–214.
8. Behrmann SJ. Complications of sagittal osteotomy of mandibular ramus. J Oral Surg 1972; 30:554–561.
9. Brusati R, Fiamminghi L, Sesenna E, Gazzotti A. Functional disturbances of the inferior alveolar nerve after sagittal osteotomy of the mandibular ramus: Operating technique for prevention. J Maxillofac Surg 1981;9:123–125.
10. Mercier P. The inner osseous architecture and the sagittal splitting of the ascending ramus of the mandible. J Maxillofac Surg 1973;1:171–176.
11. White RP, Peters PB, Costich ER, Page HL. Evaluation of sagittal split ramus osteotomy in 17 patients. J Oral Surg 1969;27:851–855.
12. Epker BN, Wessberg GA. Mechanisms of early skeletal relapse following surgical advancement of the mandible. Br J Oral Surg 1982;20:175–182.
13. Guernsey LH, De Champlain RW. Sequelae and complications of the intraoral sagittal osteotomy in the mandibular rami. Oral Surg 1971;32: 176–192.

14. Jonsson E, Svartz K, Welander U. Sagittal split technique. I. Immediate postoperative conditions: A radiographic follow up study. Int J Oral Surg 1979;8:75–81.
15. Ayoub AF, Stirrups DR, Moos KF. The stability of bimaxillary osteotomy after correction of skeletal Class II malocclusion. Int J Adult Orthod Orthognath Surg 1993;8:156–170.
16. Kundert M, Hadjianghelou O. Condylar displacement after sagittal splitting of the mandibular rami. A short term radiographic study. J Maxillofac Surg 1980;8:278–287.
17. LaBanc JP, Turvey T, Epker BN. Results following simultaneous mobilization of the maxilla and mandible for correction of dentofacial deformities: Analysis of 100 consecutive patients. Oral Surg Oral Med Oral Pathol 1982;54:607–612.
18. Macintosh RB. Experience with the sagittal osteotomy of the mandibular ramus: A 13-year review. J Maxillofac Surg 1981;8:151–165.
19. Tuinzing DB, Grebe RB. Complications related to the intraoral vertical ramus osteotomy. Int J Oral Surg 1985;14:319–324.
20. Turvey TA. Intraoperative complications of sagittal split osteotomy of the mandibular ramus. J Oral Maxillofac Surg 1985;43:504–509.
21. Van Merkesteyn JRP, Groot RH, Van Leeuwaarden R, Kroon FHM. Intra-operative complications in sagittal and vertical ramus osteotomies. Int J Oral Maxillofac Surg 1987;16:665–670.
22. Martis CS. Complications after mandibular sagittal split osteotomy. J Oral Maxillofac Surg 1984; 42:101–107.
23. Robinson M. Prognathism corrected by open vertical condylotomy. J S Calif Dent Assoc 1956;24: 22–27.
24. Hinds EC. Surgical correction of acquired mandibular deformities. Am J Orthod 1957;43: 160–173.
25. Winstanley RP. Subcondylar osteotomy of the mandible and the intra-oral approach. Br J Oral Surg 1968;6:134–136.
26. Caldwell JB, Letterman GS. Vertical osteotomy in the mandibular rami for correction of prognathism. J Oral Surg 1954;12:185–202.
27. Hall HD, Chase DC, Payor LG. Evaluation and refinement of the intra-oral vertical subcondylar osteotomy. Oral Surg 1975;33:333–341.
28. Niebergall CF, Mercuri LG. Intra-oral vertical condylar osteotomy. A national survey. J Oral Maxillofac Surg 1985;43:450–452.
29. Ayoub A, Koppel D, Moos K. Distraction osteogenesis is not an easy option. Br J Oral Maxillofac Surg 1999;37:227.