Oral Maxillofac Surg
DOI 10.1007/s10006-017-0614-5

ORIGINAL ARTICLE

Complications after orthognathic surgery: our experience on 423 cases

Marco Friscia[1] · **Carolina Sbordone**[1] · **Marzia Petrocelli**[1] · **Luigi Angelo Vaira**[1] · **Federica Attanasi**[2] · **Francesco Maria Cassandro**[3] · **Mariano Paternoster**[4] · **Giorgio Iaconetta**[5] · **Luigi Califano**[1]

Received: 3 January 2017 / Accepted: 20 February 2017

Abstract
Introduction Orthognathic surgery is widely used to correct dentofacial discrepancies. However, this procedure presents numerous possible complications. The aim of our study is to review intraoperative and postoperative complications related to orthognathic surgery based upon a 10-year period in the Maxillofacial Surgery Department of Federico II University of Naples.
Materials and methods Medical records of 423 patients who undergone orthognathic surgery in a 10-year period were retrospectively analyzed and complications was noted. Statistical analysis was conduced in order to understand if the type of surgical procedure influenced complications rate.
Results One hundred eighty-five complications in 143 (33.8%) of the 423 treated patients were reported. Complications detected were nerve injury (49 cases, 11.9%), infections (10 cases, 2.4%), complications related to fixation plates or screws (30 cases, 7.1%), bad split osteotomy (8 cases, 1.9%), secondary temporo-mandibular joint disorders (36 cases, 8.5%), dental injuries (21 cases, 5%), condilar resorption (2 cases, 0.5%), and necessity of a second-time surgery (24 cases, 5.7%).
Conclusions Serious complications seem to be quite rare in orthognathic surgery. Some of the surgical complications found are related to the surgeon experience and not strictly to the risks of the operation itself. Understanding potential complications allows the surgeon to guarantee safe care through early intervention and correctly inform the patient in the preoperative colloquy.

Keywords Orthognathic surgery · Orthognathic surgery complications · Inferior alveolar nerve injuries · Sagittal split ramus osteotomy complications · Le Fort 1 osteotomy complications

✉ Luigi Angelo Vaira
luigi.vaira@gmail.com

[1] Department of Maxillo-Facial Surgery, School of Medicine, University of Naples "Federico II", Via S. Pansini 5, 80100 Naples, Italy

[2] Statistical Science Department, School of Statistic Science, University of Rome "La Sapienza", Piazzale Aldo Moro 5, 00185 Rome, Italy

[3] Dentistry Unit, Department of Neurosciences, Reproductive and Odontostomatological Sciences, University Federico II, Via Pansini 9, 80100 Naples, Italy

[4] Department of Advanced Biomedical Sciences, Legal Medicine Unit, School of Medicine, University of Naples "Federico II", Via S. Pansini 5, 80100 Naples, Italy

[5] Department of Neurosurgery, School of Medicine, University of Salerno, Via S. Allende, 84081 Baronissi, Salerno, Italy

Introduction

Orthognathic surgery is widely used to correct congenital and acquired dentofacial discrepancies with various implications regarding masticatory function, facial pain, and esthetics. However, this procedure presents numerous possible complications. The most frequent, as reported by Sousa and Turrini [1], are nerve injury (12.13%), infections (3.41%), osteitis related to fixative materials (2.59%), TMJ disorders (2.10%), bad fractures (1.81%), scarring problems (1.78%), hemorrage (1.43%), condylar resorption (0.25%), soft tissue laceration (0.22%), and open bite (0.19%). The aim of our study is to review intraoperative and postoperative complications related to orthognathic surgery based upon a 10-year period in a single medical center (Maxillofacial Surgery Department of Federico II University of Naples).

Published online: 02 March 2017

Materials and methods

From 2005 to 2015, 451 patients underwent orthognatic surgery at the Maxillofacial Surgery Department of Federico II University of Naples. Patients lost during the follow-up or with history of facial trauma, congenital malformations or previous orthognatic surgery were excluded, and 423 subjects (200 males and 223 females, average age 37.5 years) were enrolled for the retrospective analysis. The distribution of preoperative diagnoses is shown in Table 1. All the patients underwent preoperative orthodontic treatment. Third molar extraction, if necessary, was performed at least 6 months before surgery in order to allow local healing. Otherwise, third molar extraction was performed during surgery, since several authors have shown that this procedure does not increase the complication rate [2, 3].

Of the 423 patients who underwent the surgery, 63 had Epker's bilateral sagittal split ramus osteotomy (BSSRO), 51 Le Fort 1 (LF 1) osteotomy, while 309 had bimaxillary orthognatic procedure. A total of 196 patients underwent genioplasty simultaneously with orthognatic surgery. A framework summary of the specific surgical procedures performed is reported in Table 2. The procedures were performed by the same surgeon, and in all cases, the rigid internal fixation with titanium miniplates and screws were used for osteosyntesis. Elastic intermaxillary fixation was used to guide occlusion in the first weeks.

All patients were given amoxicillin + clavulanic acid 1.2 g IV every 12 h starting the day before the surgery, and then 1 g every 12 h orally for 7 days. Clarithromycin 500 mg IV every 12 h starting the day before surgery, and then 500 mg every 12 h orally for 7 days was given to the 36 patients that presented with penicillin allergy.

Medical records of the patients were retrospectively analyzed with a schedule protocol previously described by Acebal-Bianco [4]. The diagnostic examinations and the treatment plan (anthropometric measurements, temporomandibular joint evaluation, 3-D cephalometric analysis, prediction planning, and model surgery), the operative and anesthesiologist reports, and the postoperative follow-up notes (recorded daily during the hospitalization and at 1, 2, 4, and 6 weeks, 3, 6 through 12 months) were studied. Neurosensory impairment was determined, both on the mandibular, lingual, and infraorbitary territory, with Semmes-Weinstein aesthesiometer 12 months after surgery. Neurosensory alteration at this time, if present, was considered as definitive. The facial skin sites and the tongue were tested bilaterally while the patients kept their eyes closed.

The test started with the thinner filament, followed by filaments with progressively increasing thickness. The patient was asked to raise his hand when the touch of the monofilament was felt. Each stimulus was maintained for approximately 1.5 s, and articulate movements were avoided during the use of the monofilaments. For each tested monofilament, the stimuli were applied four times in each area of interest. The stimulus response was considered positive when there were at least three (75%) correct answers (3 of the 4 correct stimuli). The Semmes-Weinstein monofilaments 2.83 and 3.22 were selected as the upper limit of normality for the detection thresholds respectively for the lower lip and cheek. Monofilament number 6.10 was used as a limit for anesthesia [5].

Data were aggregated with Microsoft Excel® spread sheet, and statistical analysis was performed using statistical packages software system 14.0 (SSPS Inc., Chicago, USA). Cramer's test has been used to evaluate statistical relationship between the type of surgical procedure and complications rate.

Table 1 Preoperative diagnoses of the sample

Malocclusion type	No. of patients	% of patients
Angle class III	211	49.8
Angle class II	171	40.4
Angle class I	15	3.5
Asymmetry	9	2.1
Open bite	17	4

Table 2 Surgical procedures of the sample

Surgical procedure	No. of patients	% of patients
BSSRO	33	7.8
BSSRO + genioplasty	30	7.1
LF1	43	10.2
LF1 + genioplasty	8	1.9
LF1 + BSSRO	151	35.7
LF1 + BSSRO + genioplasty	158	37.4

Results

In our sample, we observed 185 complications in 143 (33.8%) of the 423 treated patients. A framework summary of the complications detected is reported in Table 3 and Fig. 1.

Nerve injury occurred in 49 cases: two patients showed a lingual nerve injury (0.5%), one patient an infraorbitary injury (0.25%), while 46 patients reported an inferior alveolar nerve (IAN) injury (9.9%). In three of these cases, a section of the nerve occurred during surgery (infraorbitary in one case, IAN in two cases). Infections occurred in 10 patients (2.4%); in five cases, this complication occurred within 5 days from surgery, while other five patients presented late infections.

Other complications detected in our series were complications related to fixation plates or screws (30 cases, 7.1%), bad

Table 3 Complications detected

Surgical procedure	No.	Complications																			
		Permanent nerve injury		Postoperative infection		Late infection		Postoperative hemorrage		Bad split		ORIF complications		TMJ disorders		Condylar resorption		Second surgery		Dental injuries		Nerve section	
BSSRO	33	2	6%	0	0%	0	0%	0	0%	1	3%	3	9.1%	3	9.1%	0	0%	1	3%	0	0%	0	0%
BSSRO + genioplasty	30	5	16.6%	0	0%	1	3.3%	0	0%	0	0%	2	6.7%	3	10%	0	0%	0	0%	1	3.3%	0	0%
LF1	43	1	2.3%	1	2.3%	0	0%	1	2.3%	0	0%	3	7%	1	2.3%	0	0%	2	4.7%	3	7%	1	2.3%
LF1 + genioplasty	8	0	0%	0	0%	0	0%	0	0%	0	0%	1	12.5%	0	0%	0	0%	0	0%	1	12.5%	0	0%
LF1 + BSSRO	151	14	9.3%	2	1.3%	1	0.7%	0	0%	4	2.6%	9	6%	14	9.3%	1	0.7%	10	6.6%	8	5.3%	0	0%
LF1 + BSSRO + genioplasty	158	27	17.1%	2	1.3%	3	1.9%	1	0.6%	3	1.9%	12	7.6%	15	9.5%	1	0.6%	11	7%	8	5%	2	1.3%
Total	423	49	11.6%	5	1.2%	5	1.2%	2	0.5%	8	1.9%	30	7.1%	36	8.5%	2	0.5%	24	5.7%	21	5%	3	0.7%

split osteotomy (8 cases, 1.9%), secondary temporomandibular joint disorders (36 cases, 8.5%), dental injuries (21 cases, 5%) condilar resorption (2 cases, 0.5%) and necessity of a second-time surgery (24 cases, 5.7%).

Cramer's test conduced in order to establish a relationship between complications rate, and surgical procedure revealed that only nerve injuries are statistical dependent on the type of surgery with a higher rate in patients who undergone genioplasty with BSSRO as shown in Table 4.

Discussion

Orthognathic surgery, like any surgical procedure, is not exempt of potential complications that may occur during surgery or in the postoperative period.

Nerve injury

Nerve damage due to the section of the alveolar nerve occurs in 0.8–9.0% [4, 6, 7]. IAN lesions are the most common due to its anatomical position that exposes it to the risk of section, traction, or compression during osteotomy, splitting, or fixation of the mandible. Lingual, mental, buccal, infraorbital, and facial nerves can be also damaged during orthognathic surgery procedures [1, 8].

Two cases of lingual nerve injury, caused by the traction of the nerve during the splitting of the mandible ramus, were observed in our series. In one patient, infraorbitary nerve section during LF1 osteotomy was reported. As regards IAN injuries, anesthesia was reported in 13 cases, while in 33 patients, sensitivity was present but lower than the normal. Like reported by other authors [4, 5], IAN disturbance was significantly more frequent in patients who undergone simultaneous genioplasty procedure (Cramer's test: 0.17) [Table 5].

Infections

The frequency of infections after orthognathic surgery is reported in 1–33% of patients [9]. Contamination of the surgical field, systemic pathologies (diabetes, immune-suppression, and anorexia), poor oral hygiene, and smoke can promote infections commonly caused by pathogenic bacteria as Bacterioides, Streptococcus, Enterobacteriacee, and Pseudomonas Aeruginosa [10].

We considered the immediate postoperative infections (within 5 days after surgery) and the late infections. Five patients presented early infections during the hospitalization (1.2%), while other five patients presented late infections (1.2%). No significative incidence difference was reported between amoxicillin + clavulanic acid (9 infections, 2.3%) and clarithromycin (1 case, 2.7%) used as prophylactic therapy. Metronidazole irrigation of the surgical wound and adequate intraoperative and postoperative antibiotic therapy, as

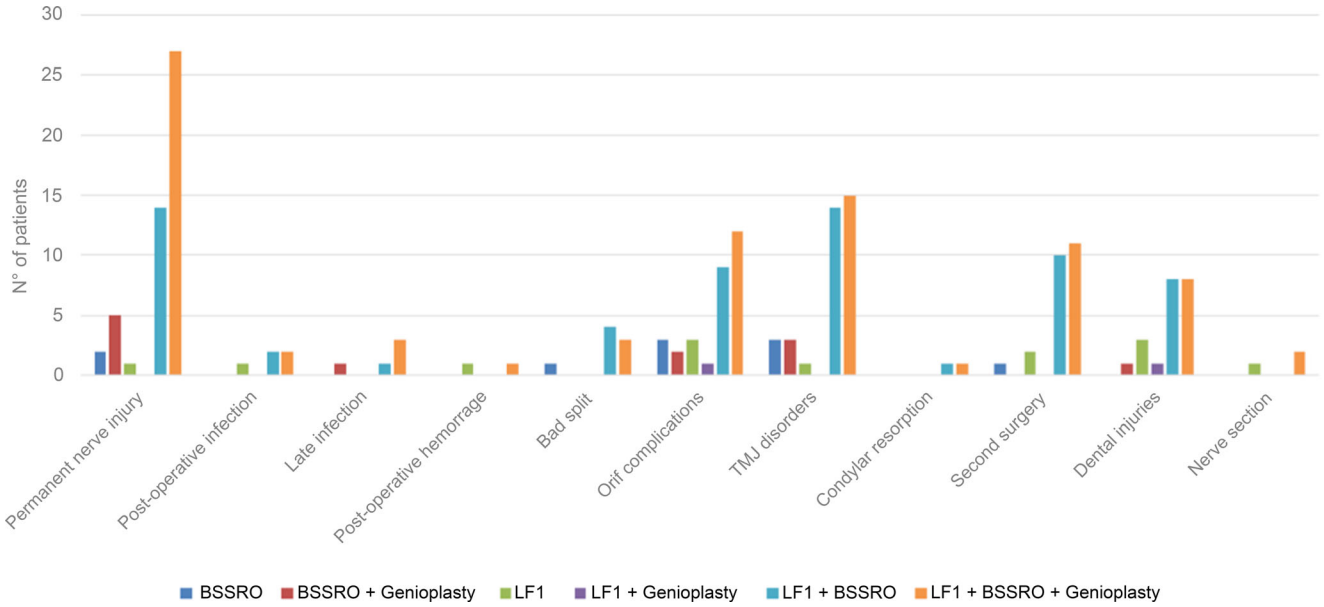

Fig. 1 Complications detected

proposed by Danda [11], can reduce infection rate after orthognathic procedures.

Hemorrhages

Bleeding is a dangerous complication that occurs in 0.05–2.2% of the cases [1, 4, 6, 12, 13]. Bleeding can arise from maxillary artery and vein, pterygoid artero-venous plexus, inferior alveolar or retromandibular artery or vein, palatine artery, or facial artery [14]. Hypotensive general anesthesia, anti-Trendelenburg position, and injection of local vasoconstrictors are recommended in order to prevent intraoperative bleeding. Severe bleeding may require blood transfusion [15]. In our series, with these preventive measures, hemorrhages occurred in five patients in the postoperative period (1.2%) requiring surgical wound exploration and hemostasis. Bleeding originated from the pterygoid plexus in four cases and from the facial artery in one case.

Dental injuries

During orthognathic surgery, the following dental lesions can be observed: odontosectioning by the drill, periodontal disease, osteolytic lesions, root absorption, and angular defects. In our series, the vitality loss of a tooth was observed in 21 cases (5%). Careful preoperatory planning may reduce the risk of dental injuries. Using correct drills and blades may help to prevent dental lesions during osteotomies [1].

Bad split

Bad fractures can be the result of an irregular osteotomy line or an unfavorable fracture, and their incidence ranges between 0.9 and 20% [16].

Bad fractures may interest the lingual or the buccal plate of the mandible or, rarely, coronoid process or mandibular

Table 4 Statistical relationship between complications rate and type of surgery

Complications	Chi statistic	Chi *p* value	Result	Cramer's V
Permanent nerve injury	11.84934	3.69E-02	Dependent	0.17
Postoperative infection	1.366425	9.28E-01	Not dependent	0.06
Late infection	3.237521	6.63E-01	Not dependent	0.09
Postoperative hemorrage	4.277437	5.10E-01	Not dependent	0.10
Bad split	2.259522	8.12E-01	Not dependent	0.07
ORIF complications	0.9184658	9.69E-01	Not dependent	0.05
TMJ disorders	3.264917	6.59E-01	Not dependent	0.09
Condylar resorption	0.7427818	9.81E-01	Not dependent	0.04
Second surgery	3.544547	6.17E-01	Not dependent	0.09
Dental injuries	3.263765	6.59E-01	Not dependent	0.09
Nerve section	3.876181	5.67E-01	Not dependent	0.10

Table 5 Nerve injuries incidence

Surgery	No.	Nerve complications					
		Anesthesia		Subnormal		Normal	
BSSRO	33	1	3%	1	3%	31	94%
BSSRO + genioplasty	30	3	10%	2	6.7%	25	83.3%
LF1	43	1	2.3%	0	0%	42	97.7%
LF1 + genioplasty	8	0	0%	0	0%	8	100%
LF1 + BSSRO	151	3	2%	11	7.3%	137	90.7%
LF1 + BSSRO + genioplasty	158	6	3.8%	21	13.2%	131	83%
Total	423	14	3.3%	35	8.3%	374	88.4%

condyle [17]. This complication can lead to infections, bone sequestration of the fragments, delayed bone healing, and pseudoarthrosis.

In our series, bad split of the mandible occurred in eight patients (3.93%). According to Beukes et al. [17], preoperative third molar extraction and a careful osteotomy execution in the case of small mandibular height or thickness may prevent bad fractures.

Problems related to surgical fixation materials

Surgical fixation materials may cause surgical wounds dehiscence, loss of the screws, loss of fixation, plate exposure, plate rupture, bone structure mobility, bone necrosis, infection related to fixation materials, and infection related to the loss of fixation [18]. In these cases, plate and screw removal is mandatory.

In our experience, problems related to surgical fixation materials occurred in 30 patients (7.1%). Among these, 25 presented osteitis, while in five patients, bone sequestration of the distal mandible fragment occurred.

Temporo-mandibular joint disorders

Among the 423 patients of our series, 149 (35.2%) reported TMJ dysfunction before surgery, and of these, 61 patients (40.9%) reported no improvement of symptoms after surgery. The improvement of TMJ disorders symptoms after orthognathic surgery may be related to the malocclusion correction [19] or the effects of the bone repositioning on the masticatory muscles [20].

Thirty-six patients (8.5%) reported the appearance of symptoms only after surgery that required gnathological and functional therapy.

Condylar resorption

Condylar resorption represents a progressive change of the condylar head shape that can occur after BSSRO. The high

Fig. 2 Complication rate

pressure that develops on the condylar head during the mandibular advancement, that stretches the soft tissue component, appears to be a probable cause for this complication [21]. Its frequency is reported between 1 and 31% with a predilection for females and advanced ages [21, 22]. Radiological signs of osteoarthrosis, temporo-mandibular joint disorders, mandibular hypoplasia, posterior inclination of condylar neck, counterclockwise rotation of the mandible, bimaxillary surgery, huge mandibular advancements, and prolonged intermaxillary fixations represent the major risk factors for this complication. In our series, only two cases (0.5%) of condylar resorption were reported. Differently from the other complications, condylar resorption may occur even years after surgery. For this reason, it would deserve a longer follow-up period that was not possible due to normal scheduling of the checks. However, other two patients returned to our attention due to condylar resorption after 12 months postoperatively.

Second surgery

In the case of malocclusion recurrence or pseudoarthrosis of the osteotomies, a second surgery is mandatory. In our series, 24 patients (5.7%) underwent a second surgery due to pseudoarthrosis (19 cases) or malocclusion recurrence (5 cases).

A precise preoperative planning with an over-correction of the discrepancy that considers the relapse tendency and stable fixation are essential to reduce the risk of these complications.

Conclusions

Although retrospective study may underestimate problems in treatment, this study can be summarized by pointing out that serious complications and various other problems seem to be quite rare in orthognathic surgery, and it is a very safe method.

Some of the surgical complications found (bad fractures, nerve and dental injuries) are related to the surgeon experience and not strictly to the risks of the operation itself [Fig. 2]. In fact, surgery is only a step of the treatment of these patients as it begins with an accurate diagnosis and a proper planning that has to progress as long as it is needed in order to obtain the best result from surgery [13]. Understanding potential complications allows the multidisciplinary team to guarantee safe care through early intervention and correctly inform the patient in the preoperative colloquy.

Compliance with ethical standards

Ethical approval The study was approved by the ethical committee of the University of Napoli "Federico II".

Conflict of interest The authors declare that they have no conflict of interest.

Role of funding sources No funding sources declared.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Sousa CS, Turrini RNT (2012) Complications in orthognathic surgery: a comprehensive review. J Oral Maxillof Surg Med Pathol 24:67–74
2. Precious DS, Lung KE, Pynn BR, Goodday RH (1998) Presence of impacted teeth as a determining factor of unfavorable spits in 1256 sagittal-split osteotomies. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 85:362–365
3. Posnick JC, Choi E, Liu S (2016) Occurrence of a "bad" split and success of initial mandibular healing: a review of 524 sagittal ramus osteotomies in 262 patients. Int J Oral Maxillofac Surg 45(10):1187–1194
4. Acebal-Bianco F, Vuylsteke PL, Mommaerts MY, De Clercq CA (2000) Perioperative complications in corrective facial orthopedic surgery: a 5-year retrospective study. J Oral Maxillofac Surg 58(7):754–760
5. Vaira LA, Massarelli O, Meloni SM, Dell'aversana Orabona G, Piombino P, De Riu G (2016) Alveolar nerve impairment following bilateral sagittal split ramus osteotomy and genioplasty. J Oral Maxillofac Surg Med Pathol. doi:10.1016/j.ajoms.2016.12.003
6. Teltzrow T, Kramer FJ, Schulze A, Baethge C, Brachvogel P (2005) Perioperative complications following sagittal split osteotomy of the mandible. J Cranio-Maxillofac Surg 33:307–313
7. Morris DE, Lo LJ, Margulis A (2007) Pitfalls in orthognathic surgery: avoidance and management of complications. Clin Plast Surg 34(3):e17–e29
8. Panula K, Finne K, Oikarinen K (2001) Incidence of complications and problems related to orthognathic surgery: a review of 655 patients. J Oral Maxillofac Surg 59(10):1128–1136
9. Patel PK, Morris DE, Gassman A (2007) Complications of orthognathic surgery. J Craniofac Surg 18(4):975–985
10. Chow LK, Singh B, Chiu WK, Samman N (2007) Prevalence of postoperative complications in orthognathic surgery: a 15-year review. J Oral Maxillofac Surg 65(5):984–992
11. Danda AK, Ravi P (2011) Effectiveness of postoperative antibiotics in orthognathic surgery: a meta-analysis. J Oral Maxillofac Surg 69(10):2650–2656
12. Gunaseelan R, Anantanarayanan P, Veerabahu M, Vikraman B, Sripal R (2009) Intraoperative and perioperative complications in anterior maxillary osteotomy: a retrospective evaluation of 103 patients. J Oral Maxillofac Surg 67(6):1269–1273
13. Iannetti G, Fadda TM, Riccardi E, Mitro V, Filiaci F (2013) Our experience in complications of orthognatic surgery: a retrospective study on 3236 patients. Eur Rev Med Pharmacol Sci 17:379–384
14. Hoffman GR, Islam S (2008) The difficult Le Fort I osteotomy downfracture: a review with consideration given to an atypical maxillary morphology. J Plast Reconstr Aesthetic Surg 61:1029–1033
15. Piñeiro-Aguilar A, Somoza-Martín M, Gandara-Rey JM, García-García A (2011) Blood loss in orthognathic surgery: a systematic review. J Oral Maxillofac Surg 69(3):885–892
16. Kriwalsky MS, Maurer P, Veras RB, Eckert AW (2008) Risk factors for a bad split during sagittal split osteotomy. Br J Oral Maxillofac Surg 46:177–179

17. Beukes J, Reyneke JP, Becker PJ (2013) Medial pterygoid muscle and stylomandibular ligament: the effects on postoperative stability. Int J Oral Maxillofac Surg 42:43–48
18. Kuhlefelt M, Laine P, Suominen-Taipale L, Ingman T, Lindqvist C, Thore'n H (2010) Risk factors contributing to symptomatic miniplate removal: a retrospective study of 153 bilateral sagittal split osteotomy patients. Int J Oral Maxillofac Surg 39:430–435
19. Karabouta I, Martis C (1985) The TMJ dysfunction syndrome before and after sagittal split osteotomy of the rami. J Maxillofac Surg 13:185
20. Onizawa K, Schmelzeisen R, Vogt S (1995) Alteration of temporomandibular joint symptoms after orthognathic surgery: comparison with healthy volunteers. J Oral Maxillofac Surg 53:117–123
21. Kobayashi T, Izumi N, Kojima T, Sakagami N, Saito I, Saito C (2012) Progressive condylar resorption after mandibular advancement. Br J Oral Maxillofac Surg 50:176–180
22. Hwang SJ, Haers PE, Seifert B, Sailer HF (2004) Non-surgical risk factors for condylar resorption after orthognatic surgery. J Craniomaxillofac Surg 32:103–111