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Unilateral sagittal split ramus osteotomy: an alternative for some cases of asymmetric mandibular prognathism

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Abstract. The objective of this study was to propose a treatment protocol for patients with lateral prognathism based on the unilateral sagittal split ramus osteotomy (USSRO). This was a prospective study involving 31 patients with lateral prognathism, who required a bilateral sagittal split ramus osteotomy (BSSRO). Two groups were formed using the proposed protocol, with specific inclusion criteria for each group: BSSRO ($n = 17$) and USSRO ($n = 14$). Occlusal parameters (dental midline deviation, overbite, and overjet) were measured preoperatively (T0), at model surgery (T1), 1 month postoperative (T2), and 1 year after surgery (T3) and compared. *P*-values of <0.05 were considered significant. No significant difference was found between the USSRO and BSSRO groups for all occlusal parameters (T0, T1, T2, and T3). In both groups, there was a significant difference between T0 and T1 and no significant difference between T1 and T2 or T1 and T3 in all of the occlusal parameters; the exception was overbite between T1 and T2 in the BSSRO group, which showed a significant difference. No patient in either group showed signs or symptoms of temporomandibular joint dysfunction at T0 or T3. USSRO was found to be a stable alternative in patients with asymmetric mandibular prognathism. At the same time, it reduced the operating time and morbidity when compared to BSSRO.

Key words: facial asymmetry; class III asymmetry; functional facial asymmetry; laterognathism; unilateral sagittal split ramus osteotomy; asymmetric mandibular prognathism.

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The term ‘dentofacial deformity’ covers a group of disorders of jaw growth and development, causing morphological (facial and skeletal), occlusal, and functional (breathing, swallowing, and speech, among others) alterations. Obwegeser classified and described maxillomandibular anomalies with the aim of defining the anatomical location of the growth and development alterations. Thus, he described anomalies affecting the maxillary base, the mandibular base, and the chin. These alterations in the size and/or position of the jaws are in three dimensions, and may occur alone or in combination[1].

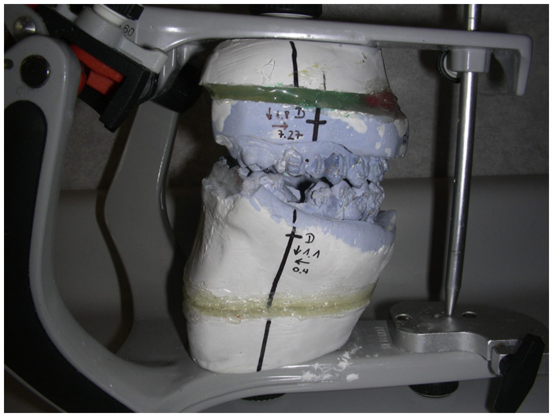

Fig. 1. A cast model in the correct position, showing minimal changes in the left ramus osteotomy.

Asymmetric prognathism is referred to using multiple terms: deviated mandibular prognathism, lateral prognathism, and dysfunctional lateral prognathism. In the heterogeneous group that presents this type of deformity, the aetiology is diverse. It can be caused by excessive growth in the isolated anteroposterior jaw or by excessive bilateral growth that is greater on one side than on the other.

Clinically, asymmetry can be observed in the lateral position of the chin and the inferior dental midline, in relation to the facial midline[2]. The treatment required for the correction of this type of pathology consists of pre-surgical orthodontic preparation followed by orthognathic surgery. The decision to correct a class III occlusion with interventions to the mandible, maxilla, or both simultaneously, is based on a careful evaluation of function (breathing, chewing, etc.) and facial aesthetics[3]. One of the surgical procedures to correct these dentofacial deformities is the bilateral sagittal split ramus osteotomy (BSSRO), first described by Obwegeser and Trauner[4], and modified by Dal Pont and Epker[5,6].

The surgical planning stages include performing the required movements to correct the defect on articulated models[7], or using three-dimensional (3D) planning[8–12]. The movement on each side of the sagittal ramus osteotomy is shown during 3D surgery planning, or on each side of the operated cast model. Occasionally when quantifying the movement, one of the sides of the ramus osteotomy (in the region of the Dal Pont vertical cut) does not change or changes minimally in the three spatial directions (viewed in the articulated models or in 3D planning) (Figs 1–3). The side that does not change, or where the change is minimal, usually shows a class I canine relationship before mandibular surgery in the articulated models.

Based on this phenomenon the question arises: Is it possible to perform a unilateral sagittal split ramus osteotomy (USSRO) for the correction of class III asymmetry when one of the sides of the osteotomy does not move, or moves minimally, in model surgery or 3D planning?

The objective of this study was to propose a USSRO treatment protocol (Fig. 4) for patients with lateral prognathism and to determine whether it is a valid surgical alternative that resolves the mandibular asymmetry, through an evaluation of its stability over time, temporomandibular joint (TMJ) symptoms, and comparison with the classic BSSRO technique.

Materials and methods

This study was designed as a controlled clinical trial and included patients diagnosed with mandibular lateral prognathism at the maxillofacial surgery service of Hospital del Salvador, Santiago, Chile, and the private practice of Dr Rodrigo Fariña, between January 2010 and December 2013. A total of 40 patients were initially recruited. All subjects included in this study were given detailed information regarding the procedures to be performed and provided informed consent to participate. The patients could freely accept or reject participation. This study was approved by the Ethics Committee of Hospital del Salvador.

Patients and group selection

The following inclusion criteria were applied for the study population: patients with asymmetric prognathism, a deviated lower dental midline, upper dental midline centred with the facial midline, and mouth opening greater than 30 mm, without clicks or joint noises, and with a requirement for bimaxillary surgery beginning with a Le Fort I osteotomy.

The exclusion criteria for both groups were as follows: asymmetry with an origin that was not lateral prognathism (such as active condylar hyperplasia), patients with a non-centred maxillary dental midline, patients who required bimaxillary surgery starting with a mandibular osteotomy, and patients who needed just a mandibular osteotomy.

The patients were divided into the two study groups according to the algorithm shown in Fig. 4 and as outlined below.

Forty patients were selected, of whom four were excluded because of asymmetry with an origin that was not asymmetric mandibular prognathism. The patients selected for the study were then divided into two groups: group A comprised 19 participants who underwent a USSRO and

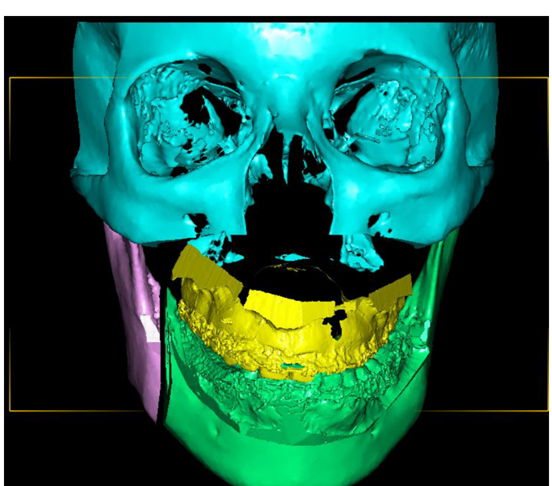

Fig. 2. Frontal view of 3D planning showing no changes to the left ramus.

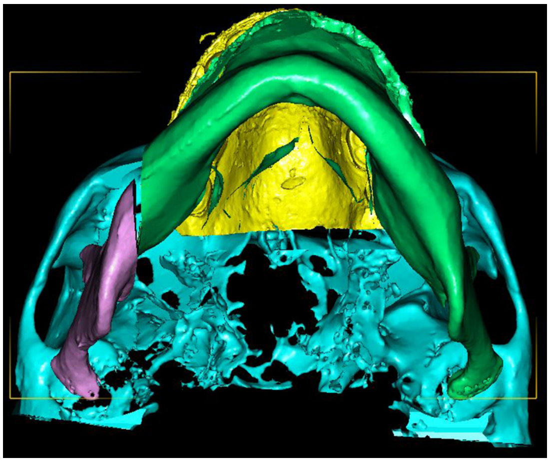

Fig. 3. Axial view of 3D planning showing no changes to the left ramus.

group B comprised 17 patients who underwent a BSSRO. All patients were planned for bimaxillary surgery beginning with a Le Fort I osteotomy.

The patients in group A were individuals who had occlusal changes of less than 2 mm in the three dimensions of space on one of the sides of the ramus osteotomy (in the region of the Dal Pont vertical cut), or a class I canine on one side of the articulated models before mandibular surgery on the articulated cast. Group B subjects were individuals who had changes greater than 2 mm on both sides of the vertical osteotomy in the sagittal split ramus osteotomy.

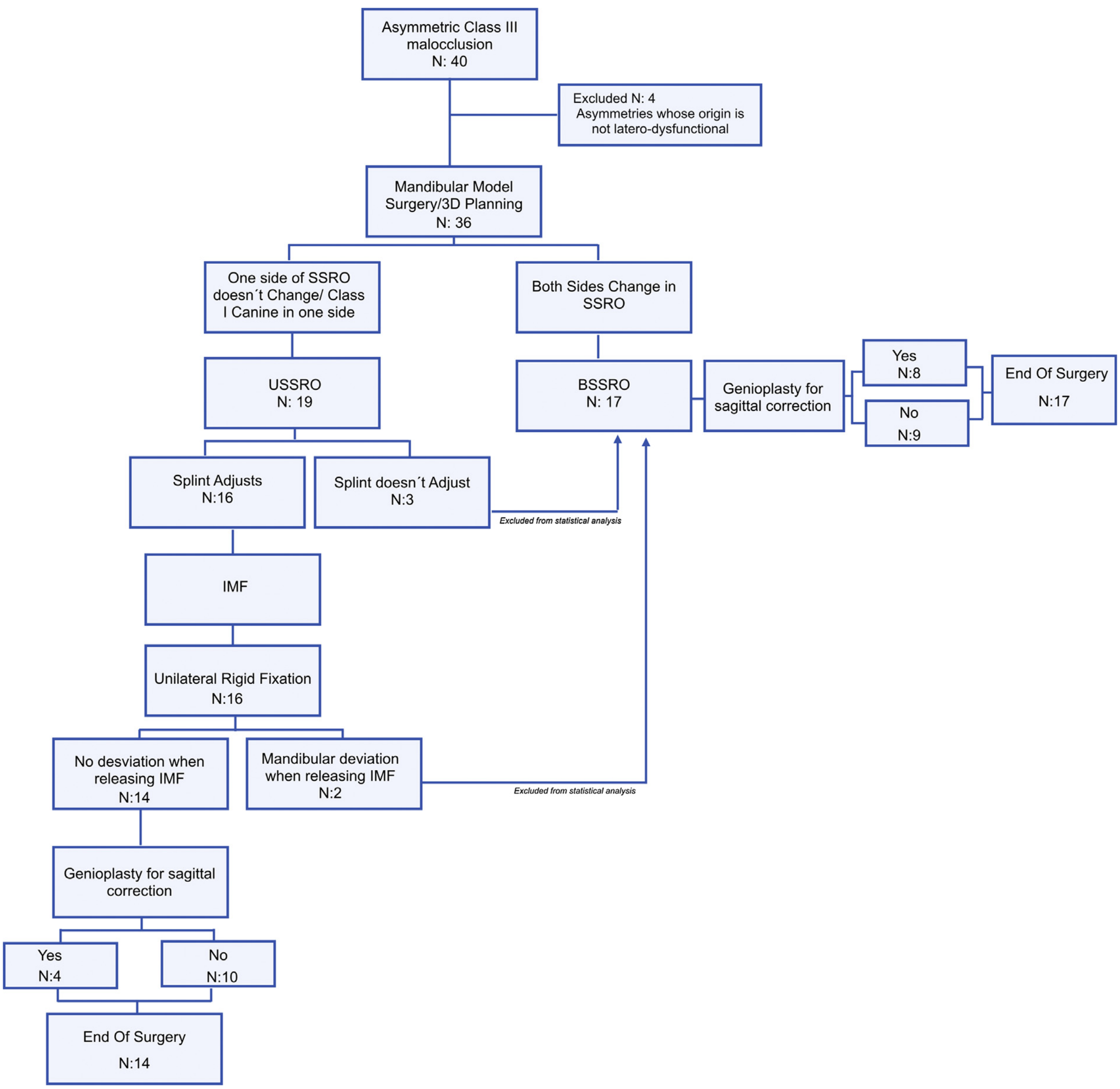

Fig. 4. Algorithm for the selection of the unilateral sagittal split ramus osteotomy protocol. SSRO, sagittal split ramus osteotomy; USSRO, unilateral sagittal split ramus osteotomy; BSSRO, bilateral sagittal split ramus osteotomy; IMF, intermaxillary fixation.

Preoperative assessment and planning

Each patient underwent standardized diagnostic examinations including lateral cephalometric radiographs, panoramic radiographs, and cone beam computed tomography (CTCB), as well as articulated dental casts, standard clinical and intraoral photographs, and a cephalometric evaluation. Cast model surgery and/or 3D surgery planning was performed for all patients.

Intraoperative evaluation and planning

The intraoperative evaluation consisted of two surgical alternatives, according to the protocol described in Fig. 4. The same criteria were used during the surgical procedure. If the splint entered passively after performing the USSRO, intermaxillary fixation (IMF) was applied. When the IMF was released, if the mandible showed a symmetrical hinge axis without deviation in the planned occlusion, then the surgery was completed without the need to continue with the osteotomy on the other side. If one of these steps did not occur (the splint did not enter passively, or there was mandibular deviation on releasing the IMF), the surgery was continued with the conventional bilateral sagittal split ramus osteotomy (Fig. 4).

Parameters of evaluation and analysis of the data

For all groups, data for analysis were obtained at the following time points: T0, preoperative; T1, cast model surgery or 3D planning; T2, 1 month after surgery; T3, 1 year after surgery. Occlusal and joint parameters were evaluated. With regard to the occlusal parameters, these included mandibular dental midline deviation (measured in millimetres), overjet (distance in millimetres horizontally between the upper incisal edge and the lower incisal surface), and overbite (distance in millimetres of the overlap between the incisal edge of the upper incisor and the lower incisor). Joint parameters were assessed through the clinical examinations at T0 and T3; the presence of clicks, noise, pain, deviations on opening and closing, and restricted mouth opening was determined.

Significant differences in dental midline, overjet, and overbite between T0 and T1, T1 and T2, and T2 and T3 were determined for each group. The differences in occlusal parameters between USSRO and BSSRO were compared at T0, T1, T2, and T3. Finally, the joint symptomatology was compared between T0 and T3 for each group.

The results were recorded and tabulated. Since the groups and parameters to be studied did not present a normal distribution (Shapiro–Wilk test), the Wilcoxon test was performed to determine the *P*-values. The software program used for the data analysis was Stata 14 (StataCorp LP, College Station, TX, USA). Values of $P < 0.05$ were considered significant.

Results

A total of 19 patients were initially included in group A (USSRO). Five of these patients eventually underwent BSSRO: three because the splint did not adjust and two because of mandibular deviation when releasing the IMF. Therefore, these patients were excluded from the statistical analysis.

In the USSRO group, there was an average mandibular dental deviation of 3.18 mm, overjet of −3 mm, and overbite of 0.43 mm before surgery. A year after USSRO, the average dental deviation was 0.14 mm, overjet was 2.18 mm, and overbite was 2.25 mm. No patient needed secondary surgery (Table 1).

In the USSRO group, the correction of the inferior dental midline (from before surgery (T0) to a year after surgery (T3)) was an average of 3.04 mm; the correction of overjet was 5.18 mm and of overbite was 1.82 mm.

In the BSSRO group, the average mandibular dental deviation before surgery was 3.18 mm, overjet was −3.17 mm, and overbite was 1 mm. A year after BSSRO, the average dental deviation was 0.18 mm, overjet was 2.12 mm, and overbite was 2.12 mm. No patient needed secondary surgery (Table 2).

In the BSSRO group, the correction of the inferior dental midline (from before surgery (T0) to a year after surgery (T3)) was an average of 3 mm; the correction of overjet was 5.29 mm and of overbite was 1.12 mm.

Patients in both groups showed satisfactory facial, skeletal, and occlusal results. None of them needed secondary surgery or suffered a clinical relapse.

Regarding the comparison of occlusal parameters between the different time periods for each group, the BSSRO group showed a significant difference in the dental midline between T0 and T1

Table 1. Deviation of the mandibular dental midline, overjet, and overbite in USSRO patients at T0 (preoperative), T1 (cast model surgery), T2 (1 month after surgery), and T3 (1 year after surgery); measurements in millimetres.

Patient	Mandibular dental midline				Overjet				Overbite				Secondary surgery	Diagnosis
	T0	T1	T2	T3	T0	T1	T2	T3	T0	T1	T2	T3		
1	4	0	0	0	−3	3	3	2.5	−1	3	3	3	No	Asymmetric class III malocclusion
2	2	0	0	0	1	2	2	2	1	1.5	2	2	No	Asymmetric class III malocclusion
3	3	0	0	0	2	3	3	3	1	3	3.5	3	No	Asymmetric class III malocclusion
4	5	1.5	1.5	1	−4	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
5	4	0	0	0	−3	2	2	2	0	2	2	2	No	Asymmetric class III malocclusion
6	1	0	0	0	−2	2	2	2	0	2	2	2	No	Asymmetric class III malocclusion
7	3.5	1	1	0	−4	2.5	3	2	1	2.5	2.5	2.5	No	Asymmetric class III malocclusion
8	3	0	0	0	−3	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
9	5	0	0	0	−3.5	2	2	2	0	2	2	2	No	Asymmetric class III malocclusion
10	5	1	1	0	−6	2.5	3	3	1	3	3	3	No	Asymmetric class III malocclusion
11	4	0	0	0	−4	2.5	2.5	2.5	0	3	3	2.5	No	Asymmetric class III malocclusion
12	3	1	1	0	−4	2	2	2	2	2	2	2	No	Asymmetric class III malocclusion
13	4	0	0	0	−4	2	2	2	3	2	2	2	No	Asymmetric class III malocclusion
14	2	0	0	0	−5	2.5	2.5	2.5	−4	2	2	2	No	Asymmetric class III malocclusion
Average	3.18	0.23	0.23	0.14	−3	2.2	2.33	2.18	0.43	2.3	2.25	2.25		

USSRO, unilateral sagittal split ramus osteotomy.

Table 2. Deviation of the mandibular dental midline, overjet, and overbite in BSSRO patients at T0 (preoperative), T1 (cast model surgery), T2 (1 month after surgery), and T3 (1 year after surgery); measurements in millimetres.

Patient	Mandibular dental midline				Overjet				Overbite				Secondary surgery	Diagnosis
	T0	T1	T2	T3	T0	T1	T2	T3	T0	T1	T2	T3		
1	6	0	0	0	−4	2	3	2	1	2	2	2	No	Asymmetric class III malocclusion
2	3	1	0	0	−3	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
3	2	0	0	0	−3	2	3	3	0	2	2	2	No	Asymmetric class III malocclusion
4	4	0	0	0	−5	2	2	2	0	3	3	3	No	Asymmetric class III malocclusion
5	3	0	0	0	−2	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
6	2	0	0	0	−2	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
7	2	0	0	0	−3	3	3	3	1	2	2	3	No	Asymmetric class III malocclusion
8	2	1.5	0	1	−2	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
9	4	0	0	0	−3	2	2	2	1	3	2	2	No	Asymmetric class III malocclusion
10	3	0	1	0	−3	2	2	2	1	2	2	2	No	Asymmetric class III malocclusion
11	4	0	0	0	−3	2	2	2	2	2	2	2	No	Asymmetric class III malocclusion
12	3	0	1	0	−5	2	2	2	2	3	2	2	No	Asymmetric class III malocclusion
13	2	0	0	0	−3	2	2	2	2	2	2	2	No	Asymmetric class III malocclusion
14	2	0	0	0	−2	2	3	2	1	2	2	2	No	Asymmetric class III malocclusion
15	3	1	1.5	1	−3	3	2	2	0	3	2	2	No	Asymmetric class III malocclusion
16	5	0	1	1	−4	2	2	2	0	3	3	2	No	Asymmetric class III malocclusion
17	4	0	0	0	−4	2	2	2	2	2	2	2	No	Asymmetric class III malocclusion
Average	3.18	0.12	0.19	0.18	−3.17	2.12	2.23	2.12	1	2.29	2.12	2.12		

BSSRO, bilateral sagittal split ramus osteotomy.

($P = 0.0003$), but no significant difference in the dental midline between T1 and T2 ($P = 0.5013$) or between T1 and T3 ($P = 0.5887$). For the USSRO group, there was a significant difference in the dental midline between T0 and T1 ($P = 0.0009$), but no significant difference in the dental midline between T1 and T2 ($P = 0.1573$) or between T1 and T3 ($P = 0.0837$) (Table 3).

When evaluating the overbite across the different time intervals, the BSSRO group showed a significant difference between T0 and T1 ($P = 0.001$) and between T1 and T2 ($P = 0.046$); however, there was no significant difference between T1 and T3 ($P = 0.102$). In the USSRO group, there was a significant difference in overbite between T0 and T1 ($P = 0.003$), but no significant difference between T1 and T2 ($P = 0.157$) or between T1 and T3 ($P = 0.496$) (Table 3).

In the evaluation of overjet across the different time intervals, the BSSRO group showed a significant difference between T0 and T1 ($P = 0.001$), but no significant difference between T1 and T2 ($P = 0.317$) or between T1 and T3 ($P = 0.157$). The same evaluation in the USSRO group showed a significant difference between T0 and T1 ($P = 0.001$), but no significant difference between T1 and T2 ($P = 0.1573$) or between T1 and T3 ($P = 0.564$) (Table 3).

The Mann–Whitney test was used to compare the occlusal parameters between the two groups and determine the *P*-values. With regard to the dental midline, there was no significant difference between the two groups at T0 ($P = 0.3696$), T1 ($P = 0.4964$), T2 ($P = 0.7554$), or T3 ($P = 0.8033$) (Table 4). This lack of significant difference was also seen for overbite (BSSRO vs. USSRO: T0, $P = 0.2898$; T1, $P = 0.7114$; T2, $P = 0.1210$; T3, $P = 0.1210$) and overjet (BSSRO vs. USSRO: T0, $P = 0.3123$; T1, $P = 0.0876$; T2, $P = 0.3577$; T3, $P = 0.3577$) (Table 4).

Pre- and postoperative images of a patient who underwent Le Fort I, USSRO, and a genioplasty are shown in Figs 5–9.

Table 3. Comparison of dental midline deviation, overbite, and overjet between the different time points in the BSSRO and USSRO groups: T0 (preoperative), T1 (cast model surgery), T2 (1 month after surgery), and T3 (1 year after surgery).

Patient	Mandibular dental midline			Overjet			Overbite		
	T0–T1	T1–T2	T1–T3	T0–T1	T1–T2	T1–T3	T0–T1	T1–T2	T1–T3
Average difference USSRO	2.95	0	0.09	5.2	0.13	0.02	1.87	0.05	0.05
Average difference BSSRO	3.06	0.07	0.06	1.05	0.11	0	1.29	0.17	0.17
P-value USSRO	0.0009	0.1573	0.0837	0.001	0.1573	0.564	0.003	0.157	0.496
P-value BSSRO	0.0003	0.501	0.588	0.001	0.317	0.157	0.001	0.046	0.102

BSSRO, bilateral sagittal split ramus osteotomy; USSRO, unilateral sagittal split ramus osteotomy.

Table 4. Comparison of occlusal parameters between the BSSRO and USSRO groups; *P*-values.

	Overjet BSSRO/USSRO	Overbite BSSRO/USSRO	Dental midline BSSRO/USSRO
T0	0.3123	0.2898	0.3696
T1	0.0876	0.7114	0.4964
T2	0.3577	0.1210	0.7554
T3	0.3577	0.1210	0.8033

BSSRO, bilateral sagittal split ramus osteotomy; USSRO, unilateral sagittal split ramus osteotomy.

Fig. 5. Frontal view before surgery.

Fig. 6. Frontal view at 3 years after surgery (Le Fort I (6 mm forward), USSRO on the left side, genioplasty (4 mm forward), and rhinoplasty).

The presence of articular symptoms was evaluated both pre-surgery (T0) and at 12 months post-surgery (T3) for each group. None of the patients in either group presented articular symptoms at T0 or at T3, nor did they present any pain, noise, articular clicks, or mandibular deviations when opening the mouth, or any restrictions in opening the mouth (they all had mouth opening of at least 30 mm).

Discussion

Dentofacial deformities can be corrected through traditional orthognathic surgery (i.e., Le Fort I and/or BSSRO with or without genioplasty)[13]. Vast experience and extensive reporting on BSSRO in the literature make it a well-known technique for correcting the lower third of the face.

There are some mandibular asymmetries that may be candidates for a USSRO, such as unilateral condylar hyperplasia[14,15] and post-traumatic malocclusions; USSRO may also be appropriate for the removal of intra-bone tumours[16]. The limited use of this technique of unilateral mandibular osteotomy is possibly due to surgeon apprehension regarding moving the condyle on the side not operated on to a position that could cause some occlusal or articular alteration during the post-operative stage, affecting the long-term stability of the treatment.

The condylar rotational tolerance in BSSRO treatments has been studied and is reported to range from 10° to 15° after orthognathic surgery[13]. In the study by Lee et al., in which the maximum mandibular movement was 7 mm in the anteroposterior direction, the condyle that was not operated on only rotated 3–4° within the glenoid cavity, and it was established that this is within the range of articular adaptation, ruling out subsequent functional alterations[16]. On the other hand, the study by Beukes et al. suggested that this type of osteotomy should only be performed in small mandibular asymmetries of less than 5 mm, measured at the level of the lower central incisor, as small rotational changes to the condyle did not affect the TMJ adversely[13].

In this study, the average deviation of the dental midline was 3.1 mm (with a range of 2 mm to 6 mm). The side not operated on rotated around its condyle and caused anteroposterior changes at the level of the mandibular dental midline. These changes depend on the length and shape of the mandible, in addition to the amount of mandibular rotation required to establish symmetry.

Fig. 7. Occlusal view before surgery.

Fig. 8. Occlusal view at 3 years post-surgery.

Fig. 9. Panoramic radiograph obtained at 3 years post-surgery.

Wohlwender et al. conducted a study on 23 patients to evaluate the long-term clinical and radiological effects on the TMJ following USSRO[17]. One patient had a mandibular relapse and another patient showed radiographic signs of bilateral condylar resorption. However, 2 years post-surgery, there were no significant differences compared to the literature on BSSRO and no patient displayed functional alterations on the side that was not operated on.

In the present study, all of the USSRO patients displayed adequate occlusal stability, with at least 1 year of postoperative follow-up. This may be due to the rotation of the segment on the side not operated on, or the larger segment, returning the condyle to its original position prior to the expression of deformity, or broken within the range of physiological adaptation. No patient displayed a TMJ disorder.

This article presents a comparative study of USSRO and BSSRO, in which there were no significant differences between the two groups in terms of the TMJ symptoms pre-surgery and post-surgery. It can be assumed that the degree of condyle rotation in the cavity was within the parameters of articular adaptation already studied in other publications. The long-term occlusal stability of both techniques was also compared, with adequate stability observed between the pre-surgery and post-surgery time points in the three spatial directions in both groups, and without differences between the two groups.

In conclusion, USSRO was found to be a stable alternative in patients with asymmetric mandibular prognathism. Furthermore, this technique had a reduced operating time and morbidity when compared to BSSRO.

Funding

None.

Competing interests

None.

Ethical approval

This study was approved by the Ethics Board of Hospital del Salvador.

Patient consent

Patient consent was obtained.

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