*Journal of Cranio-Maxillofacial Surgery* (2004) **32**, 112–118

doi:10.1016/S1010-5182(03)00124-0, available online at http://www.sciencedirect.com

# Surgical options in deep-bite mandibular deficiency with prominent chin – aesthetic considerations

Maurice Y. Mommaerts[1], Moshe Shteif[2], Kristoffel Hendrickx[1], Zvi Laster[2]

[1] *Division of Maxillo-Facial Surgery, Department of Surgery, General Hospital St. Jan Bruges, Belgium;*
[2] *Department of Oral & Maxillofacial Surgery, Poriya Hospital, Poriya, Israel*

*SUMMARY.* Introduction: **A deep-bite hypoplastic mandible associated with a strong chin poses an aesthetic challenge. Functional correction of the distal occlusion can bring the chin point beyond the ideal or normal profile line. The aim of the study was to outline the indications and drawbacks of four approaches that are currently used to deal with this problem.** Material and Methods: **A retrospective study was done using lateral cephalograms and pre- and postoperative pictures of 40 randomly selected patients, judged by a panel of four surgeons. The following parameters were studied apart from occlusion: A–P chin position, chin height, mentolabial and submental folds, cervicomental and gonial angles, antegonial notch, lower lip position, and anterior mandibular bowing.** Results and Conclusion: **Procedures that involve a setback of the chin are potentially prone to create or increase submental fullness, especially the mandibular advancement/chin setback osteotomy. Procedures involving advancement of the anterior dentoalveolar segment relative to the symphyseal prominence (e.g. mandibular advancement/chin setback osteotomy, dentoalveolar mandibular advancement osteotomy) are prone to flatten the mentolabial fold excessively. The position of the chin point after mandibular advancement–posterior rotation osteotomy is difficult to predict. Maxillomandibular posterior rotation has potentially the best aesthetic outcome, provided that the chin point is not set back. © 2003 European Association for Cranio-Maxillofacial Surgery.**

***Keywords:*** **Osteotomy; Angle Class II malocclusion; Mandible; Chin; Aesthetic**

## INTRODUCTION

A deep-bite Angle's Class II configuration is frequently accompanied by a strong chin (A–P macrogenia) on an otherwise deficient mandible (micromandibulism). However, the soft-tissue pogonion (chin point) may be dorsally, normally, or occasionally even ventrally (Fig. 1A) positioned in the facial profile. Surgical-orthodontic correction of the deep bite is often indicated from a functional viewpoint for example when there is anterior palatal occlusal trauma, periodontal disease, psychosocial handicap, 'myogenic' and/or 'arthrogenic' temporo-mandibular joint dysfunction. Options for treatment include mandibular advancement and chin setback with pre-surgical orthodontic levelling of the curve of Spee, mandibular posterior rotation–advancement osteotomy without pre-surgical orthodontic levelling, bimaxillary posterior rotation osteotomy, and dentoalveolar mandibular advancement osteotomy. All procedures are directed towards correction of the sagittal and vertical components of the malocclusion, whilst adjusting or retaining the chin point in a favourable sagittal facial relationship. Other aesthetic features to consider when planning a surgical procedure are: the chin height, mentolabial and submental folds, cervicomental and gonial angles, the antegonial notch, lower lip position, and anterior mandibular 'bowing'.

## TECHNIQUES

Each of the procedures described is as it was performed at the St. Jan General Hospital, Bruges in the patients studied.

Total mandibular advancement was carried out under general anaesthesia with bilateral sagittal split osteotomies (*Mommaerts*, 2000) and transbuccal (*Mommaerts*, 1991) or transoral (*Mommaerts*, 2000, 2002) bicortical screw osteosynthesis. When the patients requested office-based surgery under local anaesthesia (two cases), or when the advancements were large (one case), osteodistraction techniques were applied using MD-DOS (Surgi-Tec NV, Bruges, Belgium; *Mommaerts*, 2001). Total dentoalveolar segment advancement was achieved by means of a combination of total subapical osteotomy and a bilateral sagittal split osteotomy (*Booth* et al., 1976). A median vertical mandibular base osteotomy was added to facilitate mobilization of the tooth-bearing segment (Fig. 2). Bicortical screws (Surgi-Tec NV, Bruges, Belgium) and/or mesh-plates or miniplates (Titamed NV, Antwerp, Belgium) were used for fixation. Chin osteotomies were performed with minimal tissue degloving (*Mommaerts* et al., 1997b) and stabilized by means of mesh-plate osteosynthesis. Le Fort I-type osteotomies were routinely performed using a subspinal technique (*Mommaerts* et al., 1997a), unless there was a need for alar base widening. The maxilla was stabilized with four mesh-plates.

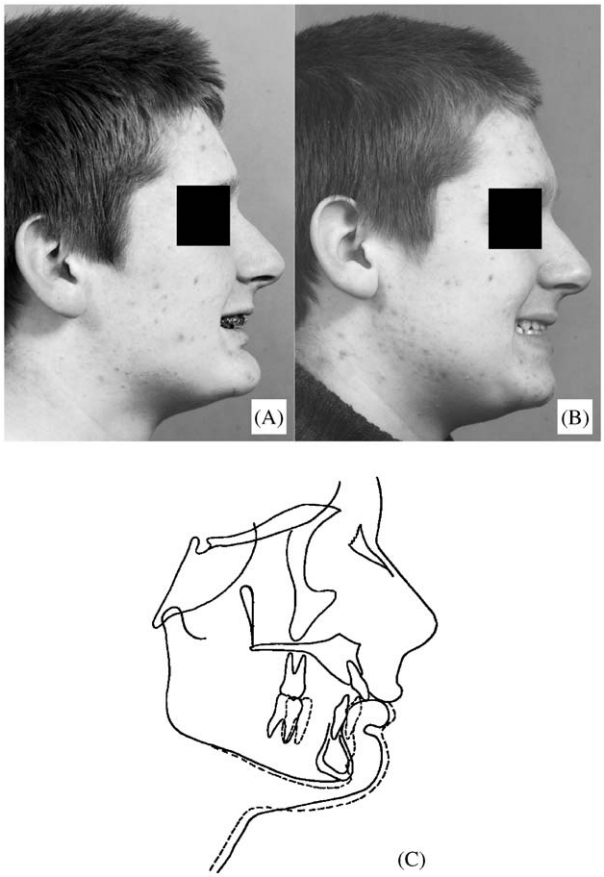


**Fig. 1** – Patient following dentoalveolar mandibular advancement osteotomy. (A) Pre-operative profile, smiling. Chin point ventrally positioned, due to its prominence and to anterior rotation of the mandible during growth (deep bite). (B) 1-year postoperative profile, smiling. Chin point assumed correct position by posterior rotation. The submental fullness can be attributed to this rotation and to weight gain. Correction of cervicomental angle can be attributed to more superior position of hyoid bone after the advancement. (C) Overlay tracing, demonstrating posterior rotation.

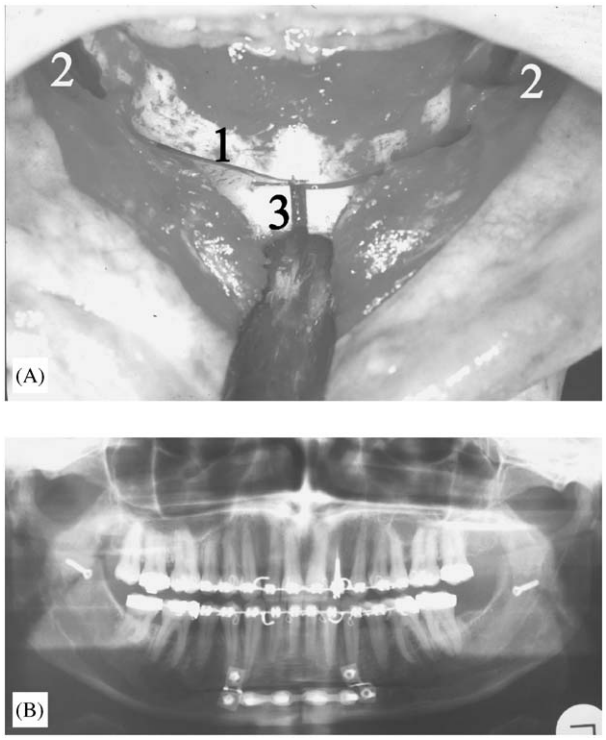


**Fig. 2** – Modified technique for dentoalveolar mandibular advancement. (A) Anterior view. The symphyseal osteotomy allows the mandibular base 'wings' to be spread, resulting in easier mobilization of the dentoalveolar segment, and direct visual control of lingual interferences. (1) Anterior subapical horizontal osteotomy, (2) bilateral 'long' sagittal split osteotomies, joining the horizontal osteotomy below the mental foramen, (3) median vertical symphyseal osteotomy. (B) Orthopantomogram after fixation with two meshplates, a median miniplate and bicortical screws in the ascending rami.

## PATIENTS AND METHODS

A retrospective study was undertaken to obtain a better understanding of the benefits and drawbacks of each of the four approaches. A prospective randomized clinical study would have been unethical, since for each patient, surgery had to be tailored according to existing knowledge about facial changes that result from these procedures, and, in addition, functional points of view including stability and the relative risks of nerve impairment have to be considered.

Forty patients (30 female, 10 male), whose ages ranged from 14.9 to 48.1 years, with non-congenital Class II deep-bite deformity, were randomly selected. Patients for whom there was insufficient data were excluded from the study, as were those who underwent suction lipectomy in combination with chin setback, or genioplasty in combination with maxillomandibular posterior rotation.

For each patient, facial profile and three-quarter profile photographs, and lateral cephalograms, taken pre- and at least 12 months postoperatively were evaluated, together with the prediction planning and the operative notes.

There were four cohorts, each of 10 patients, for the operative groups mandibular advancement/chin setback, mandibular advancement–posterior rotation, maxillomandibular posterior rotation and dentoalveolar mandibular advancement. The following critical points were assessed in all of the patients:

- sagittal position of the chin point (pogonion);
- chin height (anterior mandibular height);
- mentolabial fold;
- vertical position of the lower lip (in relation to the face);
- correction of mandibular bowing (roughly in the area of the premolars);
- submental fullness;
- cervicomental angle;
- jaw angle (gonial angle);
- antegonial notch;

A consensus opinion between four surgeons was expressed and tabulated.

**Table 1** – Evaluation of aesthetic parameters

| | Sagittal position of chin point (pogonion) | Chin height (anterior mandibular height) | Labiomental fold | Vertical position of lower lip | Correction of mandibular bowing | Submental fullness | Cervicomental angle | Jaw angle (Gonial angle) | Antegonial notch |
|---|---|---|---|---|---|---|---|---|---|
| MACS | Chin point assumed correct position (3); was not retruded enough (7) | Correct (10) | Correct (2); too flat (8) | Correct (10) | Correct or improved in cases where triangular ostectomy was performed (4) | No change (4); increased moderately (5), extreme increase (1) (Fig. 6) | No change (4); more acute(6) | No change (6); improved (4) | Improved when not present (8) |
| MAPR | Chin point assumed correct position (5); was advanced too much (5) | Correctly increased (10) | Improved (10) | Correct (10) | Not indicated | No change (9); increased (1) | No change (5); more acute (5) | No change (3); improved (7) | Improved when not present (10) |
| DAMA | Chin point assumed correct position (8); was retruded too much, due to mandibular rotation (2) | No change (1); improved by increase (2); increased too much (7) | Correct (5); too flat (5) | Correct (7); lowered too much (3) | Not indicated | No change (7); increased moderately (2), extreme increase (1) (Fig. 4) | No change (7); improved (3) | No change (5); improved (5) | No change (10) |
| MMPR | Chin point assumed correct position (8); was retruded too much (2) | Correct (10) | Correct (10) | Correct (10) | Not indicated | No change (6); increased (2); decreased (2) | More acute (10) | No change (4); improved (4); worse (2) | No change (2); improved (6); worse (2) |

MACS: mandibular advancement/chin setback osteotomy, MAPR: mandibular advancement-posterior rotation, DAMA: dentoalveolar mandibular osteotomy, MMPR: maxillomandibular posterior rotation.

## RESULTS

The consensus findings relating to the aesthetic parameters are tabulated in Table 1. Sagittal position of the chin point was usually the first feature to attract attention. Outcome was best with *dentoalveolar osteotomy* and *maxillomandibular posterior rotation*, the latter being more precisely predictable. The chin point was felt not to be retruded enough in 70% of the *mandibular advancement/chin setback osteotomy* cases (Figs. 3 and 6) and it was advanced too much in 50% of the *mandibular advancement–posterior rotation* cases.

Chin height is usually the second parameter to consider in the planning. Chin height was increased too much in 70% of the *dentoalveolar mandibular osteotomy* cases (Fig. 4).

The depth of the mentolabial fold was diminished by the uncurling of the lower lip when the dental overjet was reduced, and further by a change in the bony chin profile by chin setback or dentoalveolar advancement. Chin setback in *mandibular advancement/chin setback osteotomy* resulted in a flat chin profile in 80% of patients (Figs. 3 and 6); a feature also noted in 50% of patients treated with *dentoalveolar mandibular osteotomy* (Fig. 4). The rotational procedures did not lead to flatness.

The lower lip was positioned too low in 30% of the *dentoalveolar mandibular osteotomy* cases (Fig. 5).


**Fig. 3** – Mandibular advancement/chin setback (MACS), with correction of anterior mandibular 'bowing'. Chin setback was limited by the depth of the labiomental fold, resulting in a compromised result for both these aesthetic features. (A) Pre-operative $\frac{3}{4}$ profile view at rest. (B) 1-year postoperative $\frac{3}{4}$ profile view at rest. (C) Pre-operative lateral cephalograms. (D) 1-year postoperative lateral cephalograms. Anterior bowing was corrected by a triangular ostectomy of the wings of the mobilized chin segment, that was consequently posteriorly rotated to come in line with the posterior mandibular border.

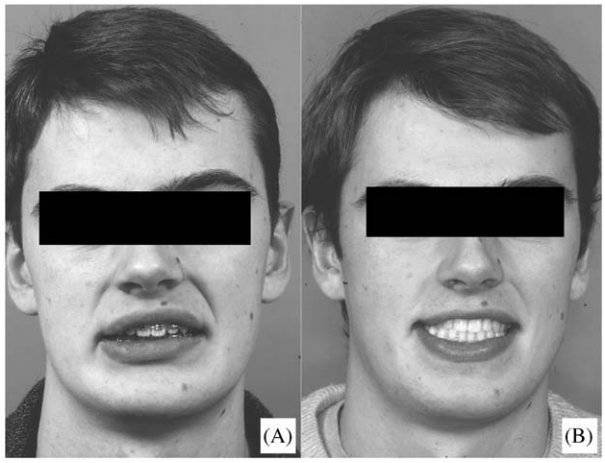


**Fig. 5** – Dentoalveolar advancement can result in a lowering of the lower lip, compromising aesthetics when smiling. (A) Pre-operative facial view. (B) Postoperative facial view. Chin height, anterior, mandibular height increased moderately.


**Fig. 4** – Dentoalveolar advancement can result in posterior rotation and increased anterior mandibular height, and increased submental fullness, especially when the occlusal correction demands a significant advancement. A simultaneous vertical reduction genioplasty is not technically feasible. (A) Pre-operative profile. (B) 1-year postoperative profile. (C) 18-month postoperative profile. A secondary chin reduction/advancement osteotomy and transmental suction lipectomy procedure has been performed.

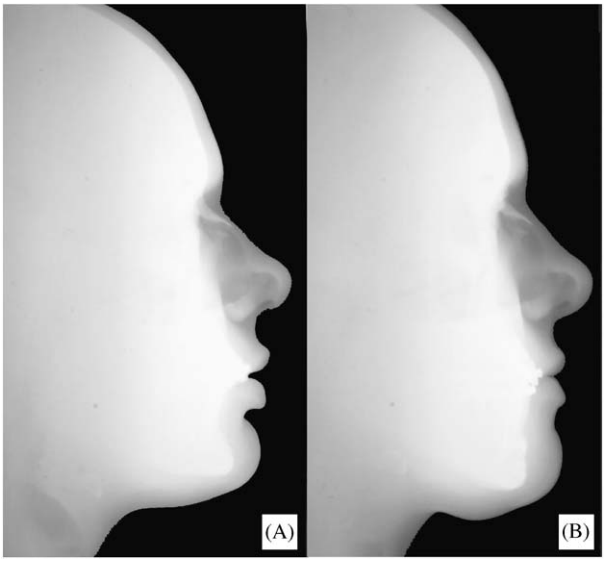


**Fig. 6** – Mandibular advancement/chin setback osteotomy can result in excessive submental fullness if transmental suction lipectomy is not performed. (A) Pre-operative lateral soft-tissue cephalogram. (B) 1-year postoperative lateral soft-tissue cephalogram. Note submental fullness, reduced chin setback and shallow labiomental fold.

However, in all of these cases, the chin height had increased.

The creation of submental fullness is an unattractive side effect and retrospective analysis showed that it occurred as soon as the chin point was retruded, whether with a chin setback procedure in 60% of the patients (Fig. 6), or with a posterior rotational procedure (*mandibular advancement–posterior rotation* 10*%, maxillomandibular posterior rotation* 20%, *dentoalveolar mandibular osteotomy* 30% – Fig. 8). Leaving aside suction lipectomy, only *maxillomandibular posterior rotation* could correct pre-existing submental fullness (20% of cases), when chin point was advanced during the rotational procedure.

The cervicomental angle decreased predictably only with *maxillomandibular posterior rotation* procedures (Fig. 7).

The change in the gonial angle after a sagittal split procedure was dependent upon the amount of bite opening and of the thickness of the soft tissues. Mere mandibular autorotation, as with *dentoalveolar mandibular osteotomy*, resulted also in a less visible mandibular angle in 50% of patients. With *maxillomandibular posterior rotation*, loss of definition of the angle was noted in the patients that also had a retrusion of chin point (20% of cases; Fig. 8).

When an antegonial notch is absent, it can be created with a sagittal split procedure, but when it is marked in thin persons, it can be hollowed out unaesthetically when precautions are not taken (*Mommaerts*, 2000). The latter occurred in 20% of the *maxillomandibular posterior rotation* cases. No change occurred when a bilateral sagittal split osteotomy was performed, as in the *dentoalveolar mandibular osteotomy* series.

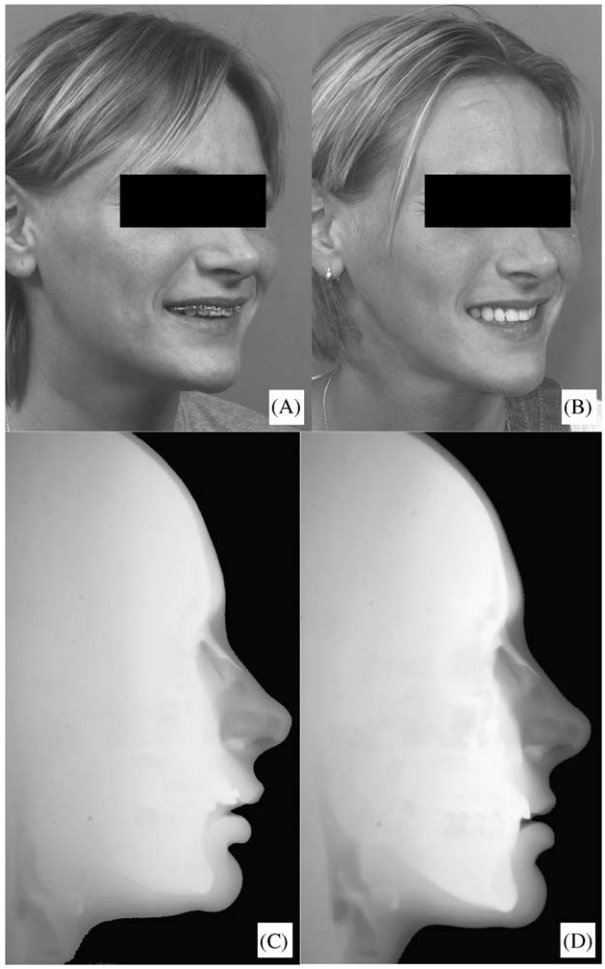


**Fig. 7** – Maxillomandibular posterior rotation predictably results in *decrease* of the cervicomental angle when the chin point is advanced. Advancement is greater at the occlusal level and the lower lip. The 'strong' chin appearance is diminished by this. Contraindications are a steep occlusal and mandibular plane, resulting in lower molar exposure when smiling, and loss of definition of the gonial angle. The upper anterior teeth should be proclined orthodontically before surgery. (A) Pre-operative $\frac{3}{4}$ profile, smiling. (B) Postoperative $\frac{3}{4}$ profile, smiling. (C) Pre-operative lateral soft-tissue cephalogram. (D) 1-year postoperative lateral soft-tissue cephalogram.

## DISCUSSION

Although all the procedures described in this study were selected to fit this one specific skeletal and soft-tissue configuration, it is believed that this retrospective analysis allows us to formulate recommendations to fine-tune the treatment options to the individual patient.

The degree and centre of rotation of *mandibular advancement–posterior rotation* are difficult to predict on cephalograms and the chin point sometimes remains too far anteriorly placed. When the curve of Spee is prominent, occlusal reduction of the posterior molars can increase the rotation achieved. In *mandibular advancement/chin setback osteotomy*, a strong chin is sometimes aimed for. However, the setback is frequently limited by excessive flattening of

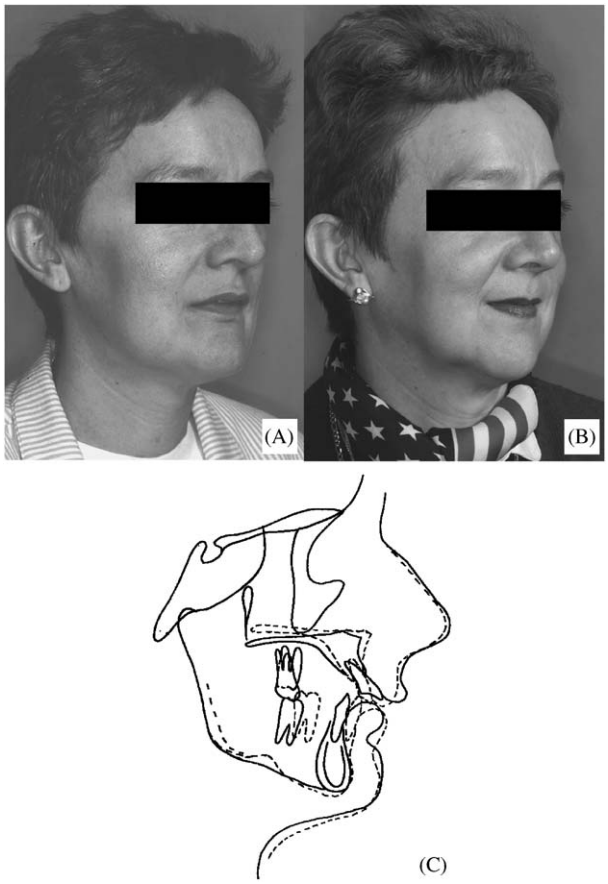


**Fig. 8** – Maxillomandibular posterior rotation results in an *increase* of cervicomental angle, increase in submental fullness, and loss of gonial definition, when the chin point is retruded. (A) Pre-operative $\frac{3}{4}$ profile. (B) 2-year postoperative $\frac{3}{4}$ profile. Note also the increased prominence of cheeks ('jowls'). Patient looks considerably older. (C) Overlay tracing.

the labiomental fold, anticipated or not. With *dentoalveolar mandibular osteotomy*, advancement of the dentoalveolar segment can make the basal mandible and chin point rotate posteriorly. This occurs when lingual bony interferences at the transition of the horizontal and sagittal splits cannot be removed sufficiently because of risk to damage the mental nerve. The procedure is technically demanding and both the amount and magnitude of the interferences cannot be predicted.

In *mandibular advancement/chin setback osteotomy*, chin height can be adjusted by vertical reduction or augmentation. Proper vertical position of the chin point can be predicted accurately with *mandibular advancement–posterior rotation* and *maxillomandibular posterior rotation*, since the only parameter determining its change is the dental overbite. Selection of the procedure was appropriate in all cases. Unanticipated increase in chin height can occur with *dentoalveolar mandibular osteotomy*. Again, this is due to the posterior rotation caused by bony interferences lingually at the transition of the horizontal and sagittal splits.

The labiomental fold is an important aesthetic feature. When confronted with the choice of retruding the chin point to the norm and flattening the fold, against retaining a stronger chin point in favour of a dimple, we recommend the choice of the latter. In our opinion, a slightly prominent chin is less detrimental to the profile than a flattened labiomental fold. The decision for *mandibular advancement–posterior rotation* or *maxillomandibular posterior rotation* is mainly related to this feature. The mechanism of labiomental fold flattening is similar in *dentoalveolar mandibular osteotomy* and *mandibular advancement/chin setback osteotomy* with the segment movements in opposite directions, but the change in the local relationship being similar. When posterior rotation can be kept minimal with *dentoalveolar mandibular osteotomy*, the labiomental fold is less prone to decrease than with *mandibular advancement/chin setback osteotomy*. *Booth* et al. (1976) presented the first case of correction by combined sagittal ramus and subapical body osteotomy of Class II malocclusion with deep bite. The postoperative result showed correction of the lower facial height and the pronounced labiomental fold, as well as the chin prominence. The 4-month postoperative cephalogram and profile photograph also showed the step in the chin region resulting in a rather high positioning of the soft pogonion.

The lower lip can be pulled down excessively with *dentoalveolar mandibular osteotomy*, mainly during smiling with too much exposure of the lower incisors. This can be due to an increase in chin height or to inefficient mentalis muscle fixation.

The mandibular lower border should be straight at its antero-lateral aspect and bowing can be efficiently corrected by means of triangular ostectomies of the wings of the chin segment. This allows the segment to be rotated posteriorly. Bowing was a sensitive indicator for selecting *mandibular advancement/chin setback osteotomy* in the study group, resulting in straightening of the mandibular border in all cases (Fig. 3). It is recommended that chin height be increased slightly to cope with the redundancy of the soft tissues. Great care should be taken to avoid damage to the inferior alveolar nerve. Pre-existing submental fullness can be corrected with a simultaneous suction lipectomy (*Mommaerts* et al., 2002). When liposuction is not appropriate because of either patient choice or where the degree of submental fullness is limited, *dentoalveolar mandibular osteotomy* may be considered.

As most deep-bite mandibles have prominent and minimally divergent angles, all procedures improve this feature by posterior rotation (*mandibular advancement/chin setback osteotomy*, *mandibular advancement–posterior rotation*, *maxillomandibular posterior rotation*) or autorotation (*dentoalveolar mandibular osteotomy*). The buccal corticotomy of the sagittal split osteotomy should, however, be directed towards the angle to maximize this effect (*Mommaerts*, 2000). How much is visible depends also upon the thickness of the integument. A loss of definition was noted in two cases of *maxillomandibular posterior rotation*, in which the Class II malocclusion and the deep bite were corrected, but

where at the same time the chin point became retruded and the gonial angle was displaced cranially. *Reyneke* and *Evans* (1999) stressed the importance of the posterior rotation of the occlusal plane around points in the maxillary region to increase aesthetic outcome. We are in favour of choosing the centre of rotation at pogonion or lower, to avoid submental fullness. It is important to be aware that the subnasal area and the nasal tip should allow for this.

## CONCLUSION

Procedures that involve a setback of the chin are potentially prone to create or increase submental fullness which is difficult to manage, even with liposuction techniques. This is especially so with the *mandibular advancement/chin setback osteotomy*. In procedures involving more advancement of the anterior dentoalveolar segment than of the symphyseal prominence (e.g. *mandibular advancement/chin setback osteotomy*, *dentoalveolar mandibular advancement osteotomy*) there can be excessive flattening of the soft-tissue profile. The position of the chin point after mandibular advancement/rotation osteotomy is difficult to predict. Maxillomandibular posterior rotation has potentially the best aesthetic outcome, provided that the chin point is not set back. *Hugo Obwegeser* (2001) stated that 'The soft tissue surplus in the chin region is more difficult to correct than are the bony abnormalities'.

## References

Booth DF, Dietz V, Gianelly AA: Correction of Class II malocclusion by combined sagittal ramus and subapical body osteotomy. J Oral Surg 34: 630–634, 1976

Mommaerts MY: Slot osteosynthesis technique (SLOT) for sagittal ramus split osteotomies. A method to optimize occlusal control and condylar seating. J Cranio-Maxillofac Surg 19: 147–149, 1991

Mommaerts MY: Osteotomia sagittal de rama para avance mandibular: diseño de Rossi o Dal Pont, osteosintesis con tornillos o con miniplacas ? Rev Esp Cir Oral Maxillofac 23: 73–80, 2000

Mommaerts MY: Office-based mandibular lengthening with the MD-DOS device. In: Samchukov M, Cope J, Cherkashin A (eds), Craniofacial Distraction Osteogenesis. Philadelphia: Mosby, 2001; 263–267

Mommaerts MY: A novel osteosynthesis plate design for routine corrective facial surgery. J Craniofac Surg 13: 585–94, 2002

Mommaerts MY, Abeloos J, De Clercq C, Neyt L: Intraoral transmental suction lipectomy. Int J Oral Maxillofac Surg 31: 364–366, 2002

Mommaerts MY, Abeloos JVS, De Clercq CAS, Neyt LF: The effect of the subspinal osteotomy on interalar rim width. Int J Adult Orthognath Surg 12: 95–100, 1997a

Mommaerts MY, Van Hemelen G, Sanders K, Vander Sloten J, Van Brussel K, Abeloos JV, De Clercq CA, Neyt LF: High labial incisions for genioplasty. Br J Oral Maxillofac Surg 35: 398–400, 1997b

Obwegeser HL. Mandibular Growth Anomalies. Terminology, Aetiology, Diagnosis, Treatment. Berlin: Springer, 2001; 421

Reyneke JP, Evans WG. Surgical manipulation of the occlusal plane. Int J Adult Orthod Orthognath Surg 5: 99–110, 1999

**Maurice Mommaerts**, MD, DMD, PhD, FEBOMS, FICS
Division of Maxillo-Facial Surgery
AZ St. Jan AV
Ruddershove 10
8000 Brugge
Belgium

Tel: +32 50 45 22 60
Fax: +32 50 45 22 79
E-mail: maurice.mommaerts@azbrugge.be

Paper received 11 December 2002
Accepted 3 September 2003