UNIVERSITÉ DE NANTES

_____

FACULTÉ DE MÉDECINE

_____

Année : 2021 N°

THÈSE

pour le

DIPLÔME D'ÉTAT DE DOCTEUR EN MÉDECINE

CHIRURGIE MAXILLO-FACIALE ET STOMATOLOGIE

par

Quentin GOGUET

_____

Présentée et soutenue publiquement le 17 septembre 2021

_____

Stabilité des grands excès verticaux maxillaires antérieurs. Faut-il préférer l'ostéotomie maxillaire totale ou en fer à cheval ?

_____

Président :	Monsieur le Professeur Pierre CORRE
Directeur de thèse :	Docteur Hélios BERTIN
Membres du jury :	Professeur Jacques-Marie MERCIER
	Professeur Boris LAURE

UNIVERSITÉ DE NANTES

TABLE DES MATIERES

UNIVERSITÉ DE NANTES

REMERCIEMENTS

A mon très cher ami le Dr Hélios BERTIN

Pour m'avoir accueilli au sein de ce service à mes tous débuts et pour m'avoir formé, guidé et soutenu pendant toutes ces années. La boucle est maintenant bouclée et je suis ravi et honoré que tu sois mon directeur de thèse.

Au Pr Pierre CORRE

Pour ta disponibilité, ton écoute, ta formation continue au sein du service et en dehors. Pour m'avoir permis d'opérer et pour ta confiance accordée durant toutes ces années.

Au Pr Jacques-Marie MERCIER

Pour vos conseils enrichissants, pour votre gentillesse et votre disponibilité au cours de ce travail de thèse, qui sans elle, aurait été bien plus compliqué et fastidieux.

Au Pr Boris LAURE

Pour votre accueil chaleureux au sein du service de chirurgie maxillo-faciale de Tours, et pour tous ces moments passés au bloc opératoire à apprendre de nouvelles techniques chirurgicales.

Au Dr Julie LONGIS

Pour l'un des meilleurs semestres que j'ai pu passer dans ce service, pour ta formation complète et exhaustive et pour m'avoir permis d'avoir un regard différent sur ma spécialité.

A ma chère amie le Dr Fanny-Laure MERLET

Qu'aurait été mon avenir sans ces deux semestres passés en ta compagnie ? Tu m'as permis d'opérer à ta façon, sans complexe, détendu, tout en gardant concentration et discipline. Je te remercie pour cela et j'espère pouvoir devenir un jour pourquoi pas, ton associé.

Au Dr Benoît PIOT

Pour ton accueil, ton flegme légendaire et la facilitation de ma transition vers le service de chirurgie maxillo-faciale de La Roche s/ Yon pour une partie de mon futur professionnel.

UNIVERSITÉ DE NANTES

A mon très cher ami le Dr François PASQUIER

Que dire de nos semestres passés ensemble, d'abord en ORL, puis en CMF, les moments passés dans le bureau, à l'internat, sur la console, à l'extérieur, (au bar) et j'en passe. Une véritable amitié s'est créée entre nous et pour cela je t'en remercie. J'espère pouvoir toujours vous voir régulièrement, toi, Marie et ta petite Suzanne malgré la distance qui s'est mise entre nous.

Aux Dr Fabien FAUVEL et Mathieu LARHANT

Pour votre accueil au sein du service de chirurgie maxillo-faciale de St Nazaire, pour m'avoir appris la vie, pour votre gentillesse et pour l'amitié que j'ai pu développer avec vous.

Aux Dr Chrystelle QUEIROS et Benjamin CROISE

D'abord co-internes à Nantes, puis chefs lors de mon passage à Tours, merci pour ces moments de complicité passés avec vous, votre gentillesse et votre patience (pour la patience je parle uniquement de Chrystelle…) avec moi, je suis ravi que notre amitié puisse continuer malgré la distance.

A mes amis rencontrés à Tours et notamment dans le service de chirurgie maxillo-faciale

Et plus particulièrement à Sarah, Chou, Ségolène, Élias, Gauthier, Hortense, Diminou, Élisa, Maëlle, Yasmine, Quitterie et tous les autres. J'y ai fait des rencontres formidables, au-delà des relations de travail habituelles, de vrais amis.

Au service d'ORL du CHU de Nantes

Aux Pr Olivier MALARD et Pr Florent ESPITALIER et tout particulièrement aux Dr Mickaël HENOUX et Dr Marine LOMBARD, au Dr Marine DRENO, à Gabi, Audrey, Sarah, Delphine, Adrien, Laura, Margot, Stéphanie, Christophe et les autres pour votre accueil chaleureux dans le service d'ORL, vos conseils, l'apprentissage d'une nouvelle spécialité et votre gentillesse pendant tout ce semestre très enrichissant professionnellement et personnellement.

A mes anciens et actuels co-internes et chefs Nantais

Et particulièrement aux Dr Justine LOIN, Dr Marine ANQUETIL, Dr Maëva BOURRY, Dr Guillaume GIRAN, Dr Guillaume MOUALLEM, Dr Anaëlle LENORMAND, Dr Mathilde MALINGE, à Pierre, Amaury, Charlotte, Sophie, Samy, Julia, Thanh-Thuy et Morgan du service de CMF, et également à Baptiste, Jérôme et Alexandre malgré la distance qui nous a un peu séparés, à Servane, Julien, Anne-Sophie, Fanny, Thomas, Antoine et Marion, Jérémy, merci à tous pour avoir été là toutes ces années, votre soutien, votre amitié, tous ces moments passés ensemble dans ma vie professionnelle comme personnelle, un immense merci, sans de vrais co-internes, il est difficile de s'en sortir, et je trouve que je m'en suis particulièrement bien sorti…

UNIVERSITÉ DE NANTES

A mes amis inter-CHU venus à Nantes

Et notamment à Tan-Mai, Kévin et Sabrina, Parisiens, Tunisienne, peu importe, une très belle amitié s'est créée entre nous, même si la distance finira par nous séparer physiquement, je ne vous oublierai pas et je sais que nous resterons en contact.

A mes amis du Centre de Soins Dentaires

Et tout particulièrement à Camille, tu es une superbe personne, je suis heureux de t'avoir rencontrée il y a finalement peu de temps mais j'ai l'impression que l'on se connait depuis des années. Merci pour ces moments passés ensemble.
A Maxime pour cette forte complicité qui s'est développée au fil des années et qui continue de perdurer, à Grégoire pour ta sagesse et tes conseils de grand frère lors de notre semestre commun, ainsi qu'à Léo, Agathe, Sarah, Adrien et aux autres.

A mon service de chirurgie maxillo-faciale dans son ensemble

Il sera difficile d'être exhaustif, merci à Mélanie, Mary, Tony, Fiona, Christine, Pierrette, Florence, Valérie, Béatrice, Aurélie, aux équipes du bloc opératoire et à tous les autres.

Aux services de neuro-traumatologie et de chirurgie cardio-thoracique

Lors de mes passages en début de cursus, merci aux Dr Édouard SAMARUT, Dr Joseph CRISTINI et Dr Constantin MORARU, au Dr Philippe LACOSTE, et à vos équipes dans leur ensemble.

A mes grands-parents et à ma tante

Pour votre soutien à distance et la fierté que vous portez pour moi.

A mes parents et à ma sœur

Pour votre soutien indéfectible pendant toutes ces années difficiles dans les bons comme dans les mauvais moments, pour m'avoir supporté durant tout ce temps, avant mon entrée en médecine, pendant les concours, pendant mon internat et mon travail de thèse. Merci d'être là, de pouvoir vous voir régulièrement et de rester soudés et unis malgré tout. Je ne le dis peut-être pas souvent, mais vous savez que je vous aime.

A toi, Laure

Pour être présente à mes côtés depuis plus de deux ans, pour me supporter au quotidien et je sais que je ne suis pas toujours facile à vivre, pour l'amour que tu me portes et que tu me porteras, merci d'être là et de partager ma vie.

UNIVERSITÉ DE NANTES

RESUME

INTRODUCTION: Vertical stability of the maxillary bone after Le Fort I (LF1) osteotomy can be compromised by the volume reduction of the nasal cavity. As a consequence, facial balance can be affected. Horseshoe (HS) osteotomy is then an alternative to the total LF1 osteotomy as it preserves the hard palate and the intranasal volume. The aim of this study was to compare the postoperative vertical stability of maxilla in both maxillary impaction techniques.
MATERIAL & METHODS: The maxillary bone stability was evaluated retrospectively in two groups of patients receiving total LF1 (n_1=20) or HS osteotomy (n_2=15) with more than 6 mm upward movement. The vertical stability was assessed on lateral cephalograms performed preoperatively, in immediate postoperative time and at the last follow-up period. A coordinate system was constructed with measurement of points C (distal cusp of the first maxillary molar), P (prosthion, the lowest edge of the maxillary alveolus of the central incisor) and I (upper central incisor edge). **RESULTS:** The two groups were comparable in terms of age, associated procedures, indications and degree of maxillary upward movement. The mean relapse for a mean follow-up of 18.3 and 21.3 months for horseshoe and Le Fort I osteotomy respectively was 0.63 ± 0.77 mm, 0.83 ± 1.75 mm and 0.50 ± 1.75 mm for points C, P and I respectively in the HS group with no statistical significance. While a mean significant relapse of 1.00 ± 1.19 mm and 1.00 ± 1.05 mm was found for the point P (p=0.005) and I (p=0.001) in the LF1 group respectively. A good nasal ventilation and an improvement of the aesthetic of the smile were assessed after a HS osteotomy. There was no difference regarding the complication rate between the two groups.
CONCLUSION: The horseshoe osteotomy represents a good alternative to total Le Fort I osteotomy for high maxillary impaction in long face syndrome deformities.

KEYWORDS

Horseshoe osteotomy, Le Fort I osteotomy, maxillary upward movement, long face syndrome

UNIVERSITÉ DE NANTES

ABBREVIATIONS

LFS: Long face syndrome

HS: Horseshoe

LF1: Le Fort I

SSO: Sagittal split osteotomy

RL: Ramus lengthening

PPP: Posterior palatal pedicle

CBCT: Cone beam computed tomography

N: Number of patients

SD: Standard deviation

NS: Non-significant

INTRODUCTION

The long face syndrome (LFS) was first described by Schendel who demonstrated the excessive vertical growth of the maxilla (1). Initially, LFS was associated to open-bite but he described that both open-bite and close bite can be found in LFS and that open-bite was not a specific feature of LFS. Tourne *et al.* proposed that LFS could be caused by oro-facial dysfunctions during the cranio-facial growth as it has been demonstrated in animal (2). An induced nasal breathing dysfunction in the monkey in the first three years of life could generate an abnormal muscular contraction of orofacial and neck muscles and by the soft tissue stretching leading to a LFS at the end of growth. The LFS was then defined as a long narrow face, a narrow nose and nasal apertures, a short upper lip associated to a mouth-open posture and a lengthening of the lower anterior face. Solow *et al.* proposed a self-perpetuating circle of events leading to morphologic changes in the cranio-facial complex (3) (figure 1). However, some authors did not find a consistent relationship between the obstructed naso-respiratory function and the adenoid facies or LFS, although a cause and effect relationship seems to exist (4).

The clinical and radiological features associated to the LFS are presented in table 1.

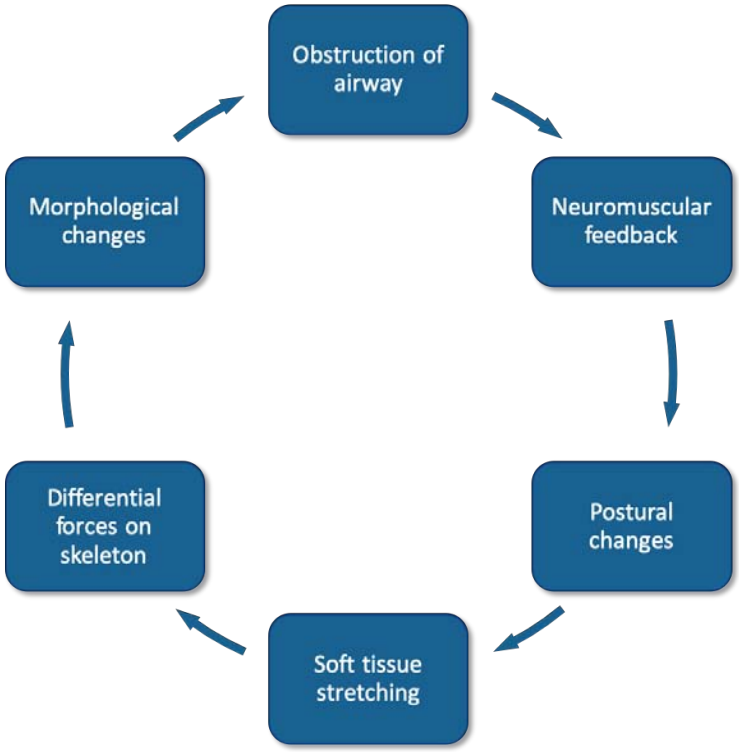

Figure 1. Self-perpetuating circle of events leading to morphologic changes in the cranio-facial complex, from Solow *et al.* (3).

Clinical characteristics	Radiological characteristics
Vertical anterior maxillary excess	Vertical anterior maxillary excess
Lip inocclusion at rest ± short upper lip	Maxillary global excess ≧ 6 mm
Unsightly gummy smile	Anterior and posterior alveolar hyperplasia evidenced by the distance between the palatal root of the second maxillary molar and PPP
Oral breathing	
Ogival palate	

Table 1. Retained clinical and radiological features of the LFS. PPP, posterior palatal pedicle.

The surgical management of LFS requires isolated or associated techniques including a maxillary upward movement by Le Fort I osteotomy (LF1), a counterclockwise rotation of the occlusal plane, a vertical reduction genioplasty, a mandibular sagittal split osteotomy (SSO), or a ramus lengthening osteotomy (RL) (5)(6)(7).

The total Le Fort I osteotomy as we know today for the correction of facial deformities was first described by Wolford, Epker and Bell (8,9). This technique was designed for sagittal and vertical movements, including upward movement to correct the vertical maxillary excess in LFS. However, these techniques are not always sufficient to correct severe LFS with facial hyperdivergence. Unfortunately, it could fail for an important vertical movement because of the position of the inferior turbinates. The turbinectomy was initially considered by Bell (10) but quickly replaced due to several complications by a total maxillary alveolar osteotomy described by Hall and Roddy, and West and McNeill (11,12). This technique, known as the horseshoe osteotomy (HS), does not need for a move of the hard palate and so that does not result in a conflict with turbinates. There is a few literature on this technique in orthognathic surgery, because of the limited indications; this technique is usually cited in preimplant surgery (13,14). Videlaine *et al.* had previously described the technique as an alternative to LF1 for patients suffering from a long face syndrome with maxillary alveolar hyperplasia, but with no evaluation of the long terms results (15). We assume that the HS osteotomy is more

stable over time than LF1 osteotomy for great maxillary upward movement, and does not result in postoperative deficiency of the nasal breathing.

The aim of our study was to radiographically compare the long-term stability of HS and LF1 osteotomies with great upward movement in patients with long face syndrome.

MATERIAL AND METHODS

Population study, indications

This monocentric retrospective study included patients with LFS, who were given a total LF1 osteotomy or a HS osteotomy. All the procedures were carried out in the maxillofacial and stomatology surgery department of the Nantes University Hospital (France). The same operator (JMM) performed most of the procedures. In this retrospective study, no change to the current clinical practice or randomization was performed. An ethics committee approval was not required in order to use these data in the epidemiologic study, as per French legislation article L. 1121-1 paragraph 1 and R1121-2 of the Public Health Code.

1. Horseshoe osteotomy group

All the patients who received a HS osteotomy between 1992 and 2020 were included in the HS group.

The inclusion criteria were:

- HS osteotomy with at least 6 mm of alveolar bone upward movement reported on operating report,
- long term follow-up of minimum one year,
- complete file with preoperative lateral cephalograms, at immediate postoperative time, and at the last follow-up.

2. Total Le Fort I osteotomy group

We included in the total LF1 osteotomy group all the patient who received a total LF1 osteotomy, between 2004 and 2020.

The inclusion criteria were:

- Total LF1 osteotomy with at least 6 mm of maxillary upward movement reported on operating report,
- long term follow-up of minimum one year,
- complete file with preoperative lateral cephalograms, at immediate postoperative time, and at the last follow-up.

The exclusion criteria were:

- LF1 osteotomy with no ascension,
- fragmented LF1 osteotomy,
- asymmetric ascension,
- syndromic patients

Surgical Procedure – Horseshoe osteotomy

A maxillary vestibular incision was performed by contouring the upper lip frenulum and reaching the periosteum. Then a subperiosteal flap allowed to expose the emergence of infra-orbital nerve, and the pterygomaxillary junction. The nasal floor was lift of and the piriform orifices were lowered to the height of the planned maxillary upward movement. For this step a sufficient anterior alveolar bone excess was needed to avoid tooth root damages. Then the classical Bell osteotomy line was performed on the anterior wall of maxillary sinus at the level of new nasal floor, but remaining very superficial. The same osteotomy line was performed above the first one allowing for maxillary upward movement after removal of the bone resection. It is crucial at this step to respect the inter-sinus-nasal wall and the nasal septum. The pterygo-maxillary disjunction was performed. The anterior nasal spine was resected. The osteotomy was completed by positioning the piezotome or bone scissors behind premaxillary tooth roots and nasopalatine canal for the anterior part, and against the hard palate through the maxillary sinus cavity for lateral osteotomy. On posterior part, the osteotomy was performed between the second molar palatal root and the posterior palatal pedicle (PPP). A down fracture was carried out and the palatal fibromucosa was detached from the palatal bone. Inter-sinusal-nasal septa, nasal septum and palatal bone with new positioned nasal floor were respected, only the dental arch was mobilized (figures 2 and 3). Interferences were removed and PPP were carefully individualized. Osteosynthesis was performed with four titanium plates of 0,6 mm thickness fixed on canine pillars and maxilla-zygomatic arches.

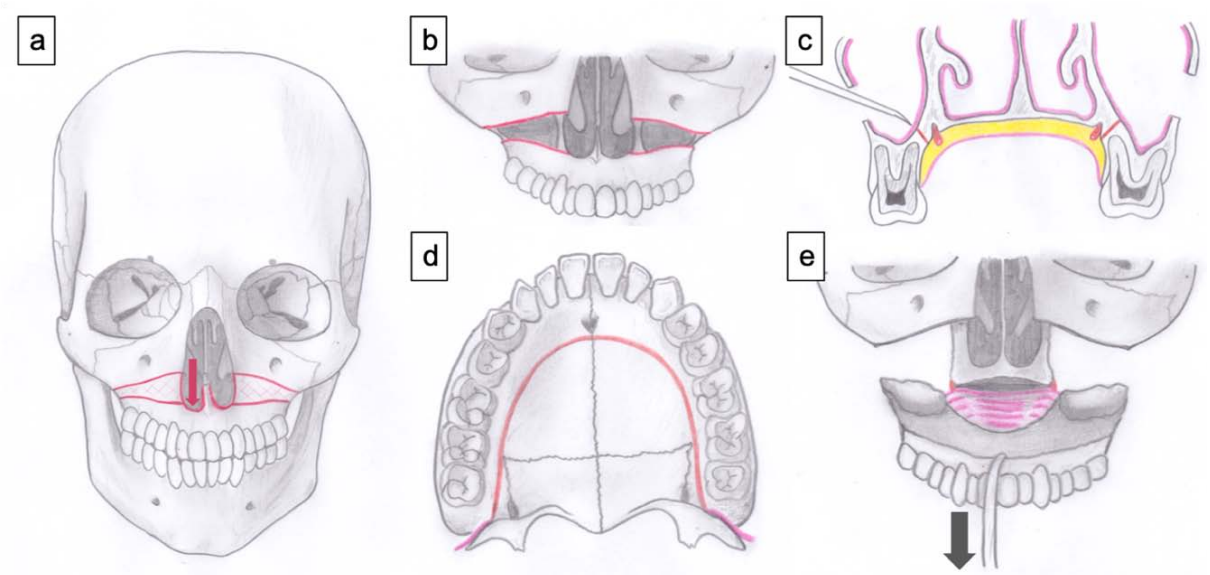

Figure 2. Horseshoe osteotomy technique. **a**: piriform orifices digging (red arrow) and bone resection equivalent to predicted upward movement **b**: respect of the nasal septum and the inter-sinusal-nasal septum. **c**: palatal osteotomy line (red bars) between the second molar palatal root and the posterior palatal pedicle. **d**: palatal osteotomy line behind the nasal-palatal pedicle and externally to posterior palatal pedicle, and pterygo-maxillary disjunction. **e**: maxillary HS down fracture (black arrow), palatal fibromucosa detached with respect of the hard palate.

Depending on the clinical and cephalometric analysis, a SSO, a RL, or a genioplasty could be associated. An intermittent maxillomandibular fixation with elastics was recommended for six weeks after the procedure, associated with a mixed diet. An orthodontic treatment was usually started at least one year before surgery and continued during six months in postoperative period. A surgical splint was used during surgery to allow the positioning of the maxilla in the predeterminate position and in the desired dental occlusion. Speech therapy is also started very early after surgery, in order to improve tongue positioning, nasal breathing, and swallowing and phonation disorders

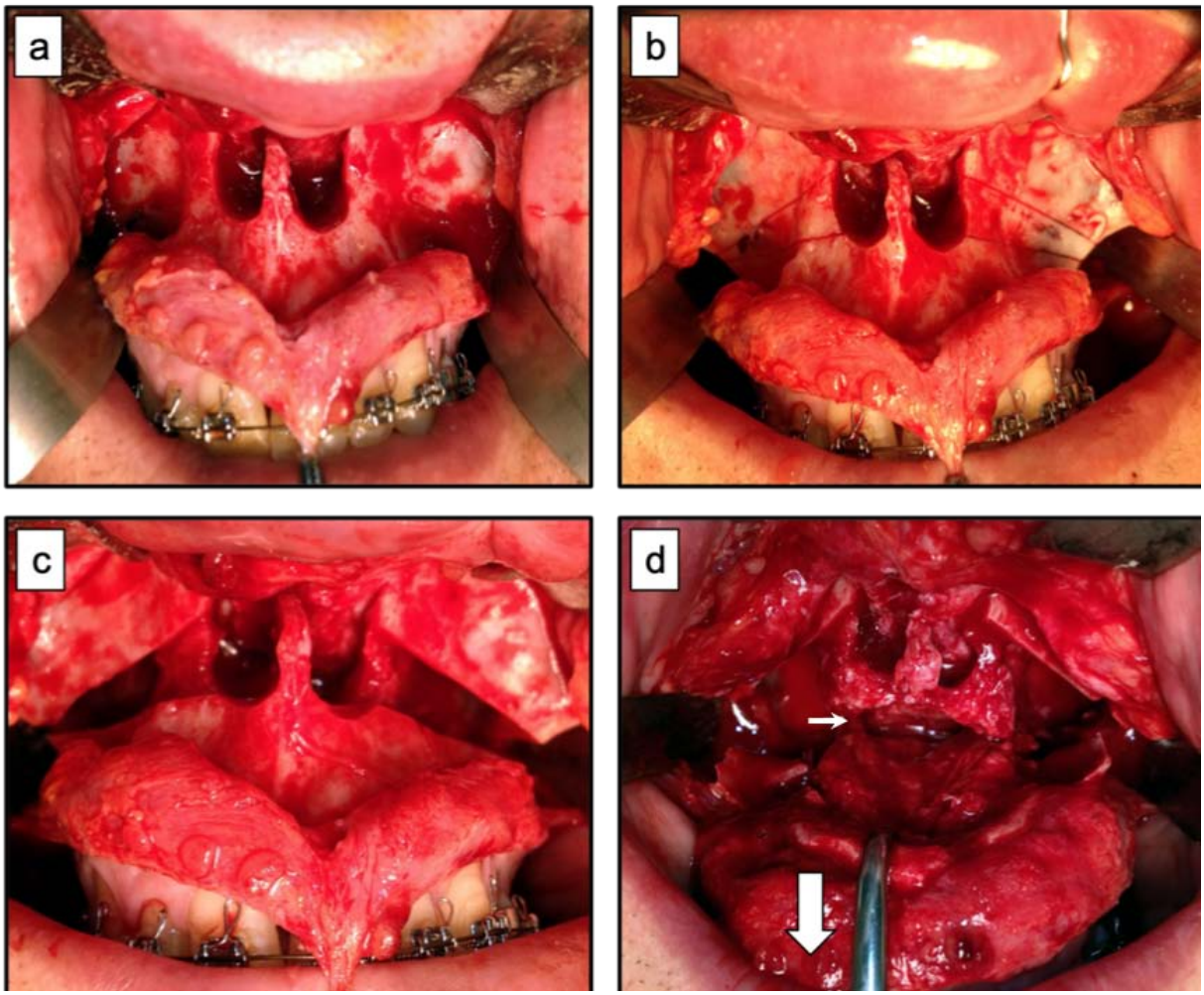

Figure 3. Intraoperative photographs of the horseshoe osteotomy. **a**: piriform orifices digging. **b**: osteotomy lines allowing for upward movement. **c**: respect of the inter-sinusal-nasal septum. **d**: maxillary horseshoe down fracture (vertical white arrow), palatal fibromucosa detached and respect of the hard palate and PPP (horizontal white arrow).

Stability study

The radiographic analysis was made on lateral cephalograms; all the radiographs were made with the same radiological parameters at 73kV and 40mA/s (Siemens, Erlangen, Germany). Three landmarks were studied on the preoperative cephalogram (T0), the immediate postoperative time (T1), and at the last follow-up (T2):

- Point C corresponded to the distal cusp of the first maxillary molar,
- point P (prosthion) was defined as the lowest edge of the maxillary alveolus of the central incisor,
- point I was the upper central incisor edge.

As previously described by Nimeskern (16) and then by Marion *et al.* (17) and Vincent *et al.* (18), coordinates were defined manually in an orthonormal frame composed by the lines (figure 4):

- C1 for the x-axis: top line of the skull base of Delaire's cephalometric analysis (clinoid point Cl' (middle of Cla-Clp line) – point M (frontal-nasal, frontal-maxillary and maxilla-nasal sutures union)),
- and C0 for the y-axis: perpendicular to C1 through the clinoid point Cl'.

The analysis of cephalometric data and the evaluation of the maxillary stability in each group were obtained by collecting the coordinates of points C, P, and I in the same fixed orthonormal frame (C1 : C0) for each patient in each group during the different periods of the study (T0, T1, T2).

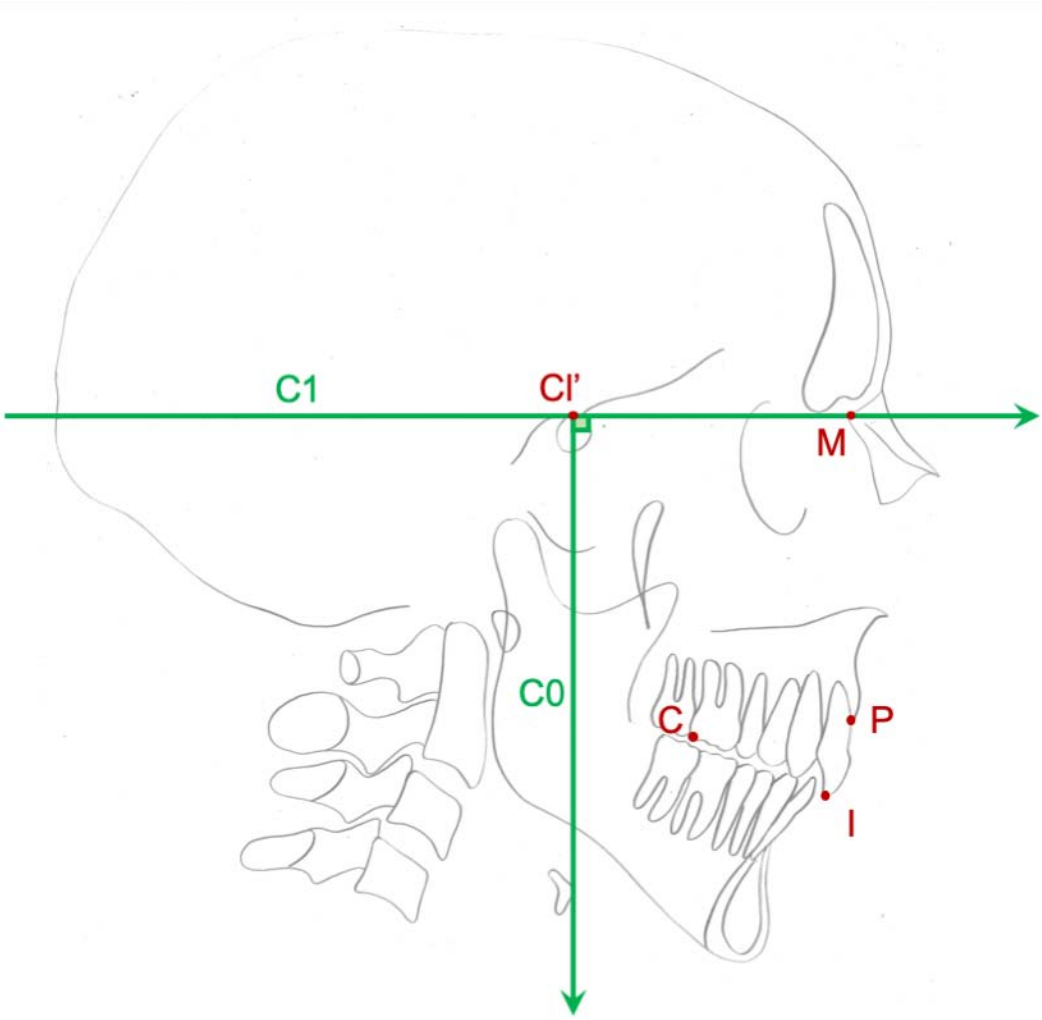

Figure 4. Representation of lateral cephalogram, orthonormal landmarks. C1 corresponding to the x-axis: upper line of the skull base of Delaire's cephalometric analysis (clinoid point Cl' - point M, frontal-nasal, frontal-maxillary and maxilla-nasal sutures union) and C0 corresponding to the y-axis: C0 line perpendicular to C1 through the clinoid point Cl'. C, distal cusp of the maxillary first molar; P, the lowest edge of the maxillary alveolus of the central incisor, prosthion; I, upper central incisor edge.

The coordinates of each point were compared between T0 and T1 to quantify dentoskeletal upward movement during surgery, and between T1 and T2 for the long-term stability study. Relapse was assessed in millimeters of relative loss of the intraoperative movement.

The statistical analysis was performed using GraphPad Prism 5.0 software for Mac (GraphPad Software, La Jolla, CA, USA). The qualitative data were analyzed using a Fisher exact test, while the quantitative data were analyzed using a Mann and Whitney test. A p-value of less than 0.05 ($p < 0.05$) was taken to indicate statistical significance.

Smile assessment

Patients with LFS were all suffering from an important gummy smile. This condition is one of the main indications for a HS osteotomy. We assessed the aesthetic of the smile in HS osteotomy group using the Kokich criteria (19–21) (figure 5):

- Gummy smile,
- occlusal plane canting,
- maxillary inter-incisors point centering,
- maxillary central incisors tilting,
- black corridors.

Figure 5. Kokich criteria for smile assessment. **a**: gummy smile. **b**: occlusal plan canting. **c**: maxillary inter-incisors point centering. **d**: maxillary central incisors tilting. **e**: black corridors.

For each patient all these criteria were assessed on ten points (0 was the least aesthetic smile, 10 was the most aesthetic), on preoperative smile and occlusion photographs and at the last follow-up. Ten assessors who were maxillofacial surgeons, orthodontists, or lay people carried out this analysis in random order. The preoperative score was compared to the postoperative one for each criterion, for each patient.

Respiratory assessment

Each patient who received a HS osteotomy was called by phone to collect their initial breathing (nasal or oral), their snoring and the modification of these criteria with the surgical procedure.

RESULTS

Epidemiologic data

Between 1992 and 2020, 31 HS osteotomies were performed. Sixteen patients were excluded from the study for missing X-rays or missing files, then fifteen patients were finally included in the study. We reported three hundred and eighteen procedures of total LF1 osteotomy between 2004 and 2020. Two hundred and ninety-eight patients were excluded from the analysis because of an ascension inferior to 6mm (247 patients), an asymmetric ascension (38 patients), and missing X-rays or files (13 patients). Twenty patients were finally included in the total LF1 osteotomy group (figure 6). The mean age at surgery was 23 ± 7.6 years for the LF1 group and 25 ± 9.8 years for the HS group. The mean follow-up was 21.3 ± 18.1 months for the LF1 group and 18.3 ± 18.2 months for the HS group. The two groups were comparable in terms of age at surgery (p=0.713), follow-up duration (p=0.255), dentoskeletal deformity (p=0.089), associated procedures (p=0.216), and maxillary ascension for each point analyzed (p=0.138 for point C, p=0.535 for point P, and p=0.525 for point I). The only difference between the two groups concerned the sex with significant more female in the LF1 group compared to HS group (p=0.027).

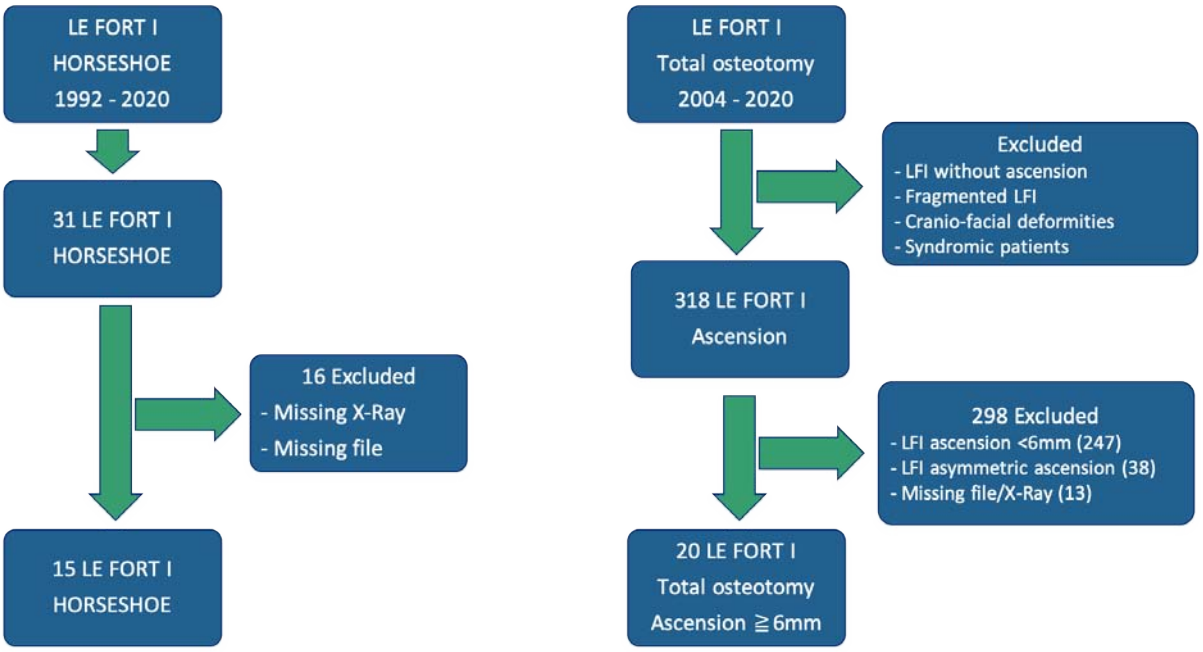

Figure 6. Flow Chart.

Most of the patients presented a class II dentoskeletal deformity. An associated orthognathic procedure was associated most of the time, consisting in a bilateral SSO or a mandibular lengthening. All the patients in HS group and most of the patients in LF1 group were given an associated genioplasty. All the epidemiologic data are presented in table 2.

	HORSESHOE n=15	**LE FORT I** n=20	
Age at surgery (years), mean ± SD	25 ± 9.8	23 ± 7.6	p=0.713
Sex			p=0.027
Male, n (%)	8 (53)	3 (15)	
Female, n (%)	7 (47)	17 (85)	
Follow up (months), mean ± SD (min-max)	18.3 ± 18.2 (1 - 73)	21.3 ± 18.1 (2 - 91)	p=0.255
Dentoskeletal class			p=0.089
I, n (%)	5 (33)	1 (5)	
II, n (%)	8 (53)	15 (75)	
III, n (%)	2 (13)	4 (20)	
Associated procedures			p=0.216
SSO, n (%)	9 (60)	12 (60)	
RL, n (%)	0	4 (20)	
Genioplasty, n (%)	15 (100)	18 (90)	
Maxillary ascension			
Point C, mean (mm) ± SD (min-max)	5.0 ± 1,7 (3 - 9)	4.0 ± 1.9 (0.5 - 8)	p=0.138
Point P, mean (mm) ± SD (min-max)	6.1 ± 2.1 (3 - 9.5)	6.4 ± 1.4 (4 - 9.5)	p=0.535
Point I, mean (mm) ± SD (min-max)	5.8 ± 1.9 (3 - 9)	6.2 ± 1.4 (4 - 9)	p=0.525

Table 2. Epidemiologic data. n, number of patients; SD, standard deviation; SSO, sagittal split osteotomy; RL, ramus lengthening.

Stability study

For all the patients, we logically obtained a significant ascension of the maxillary bone between T0 and T1 regarding the points C, P and I (figure 7). The relapse was evaluated between T1 and T2 in both groups.

A significant relapse was noted in the LF1 group for the points P and I with a mean relapse of 1.00 ± 1.19 mm for the point P (p=0.005) and 1.00 ± 1.05 mm for the point I (p=0.001). A relapse of 0.55 ± 1.13 mm was measured for the point C, with no statistical significance (p=0.051).

In the HS group, we observed a mean relapse of 0.63 ± 0.77 mm, 0.83 ± 1.75 mm and 0.50 ± 1.75 mm for points C, P and I respectively, with no statistical significance (p1=0.052, p2=0.066, and p3=0.36 respectively). The boxplot diagrams for the three points studied are presented in figures 8, 9 and 10. The case of a patient is presented in figure 11.

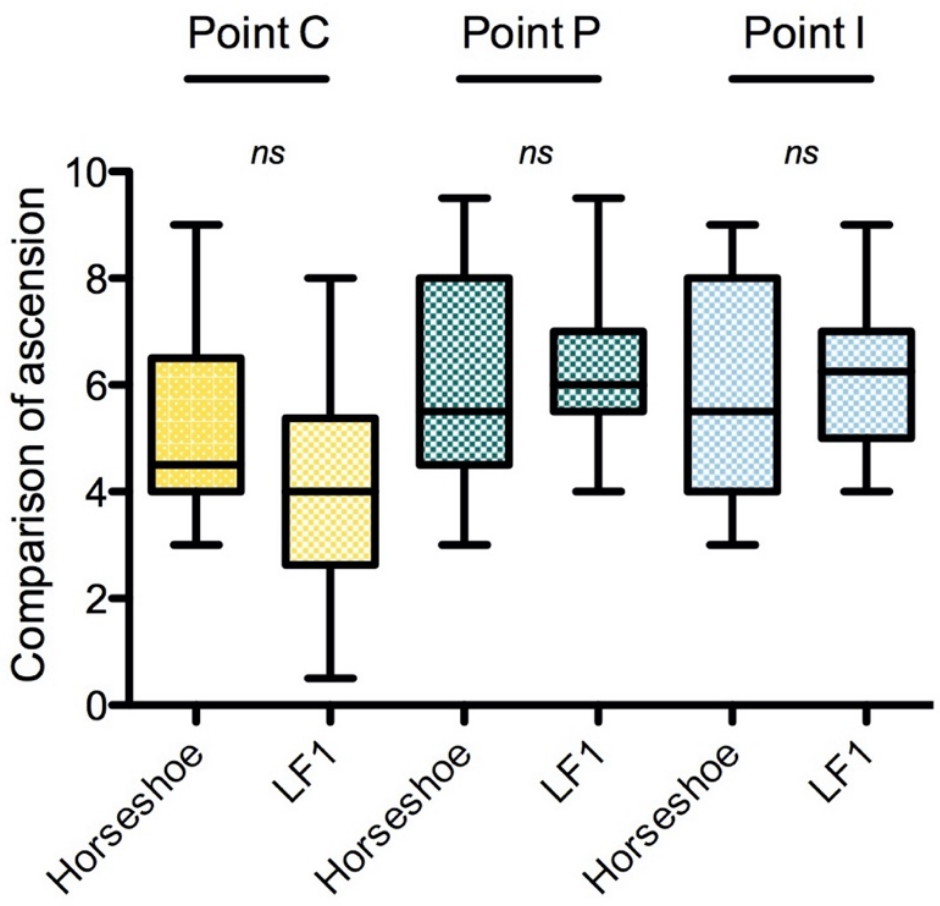

Figure 7. Comparison of the maxillary ascension (T0-T1) between HS and LF1 osteotomies for the points C, P and I. ns, non-significant; LF1, Le Fort I.

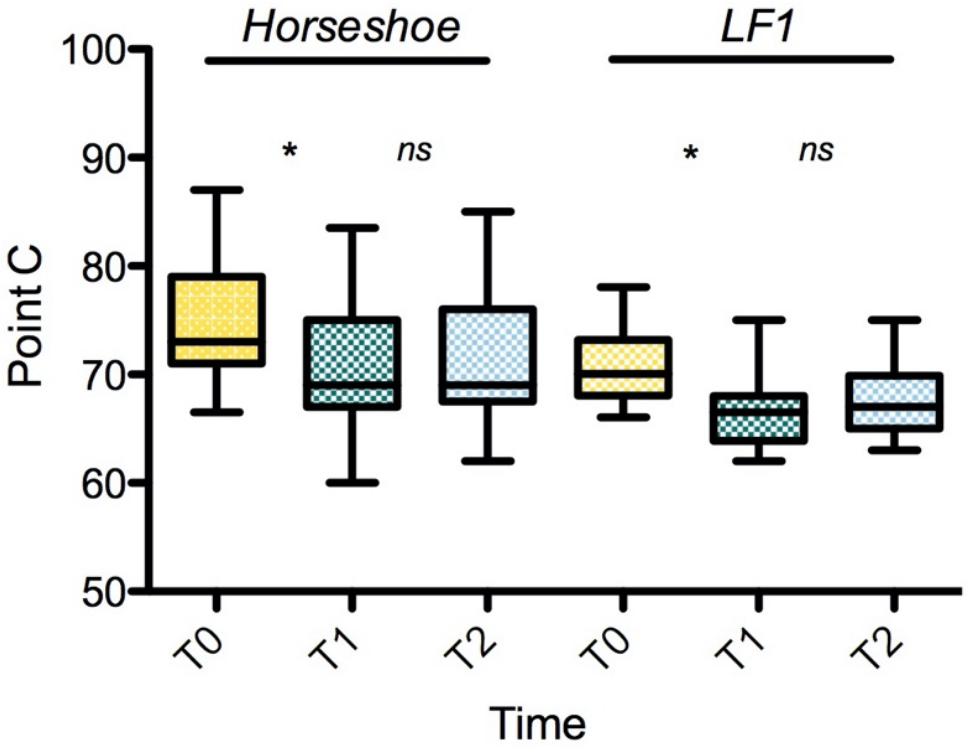

Figure 8. Study of the maxillary stability on point C for the two groups studied. ns, non-significant; LF1, Le Fort I; *, p<0.05.

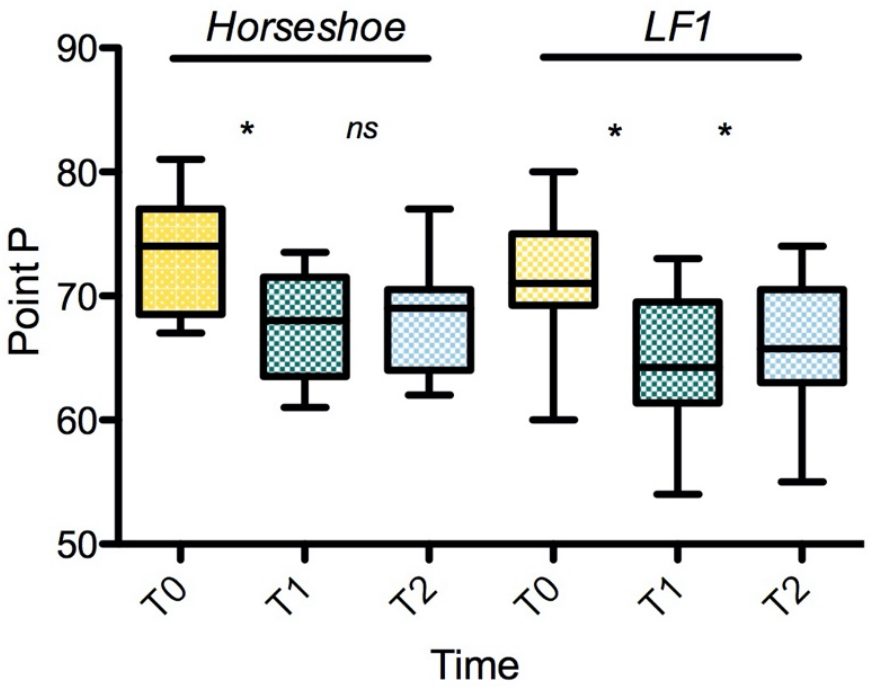

Figure 9. Study of the maxillary stability on point P for the two groups studied. ns, non-significant; LF1, Le Fort I; *, p<0.05.

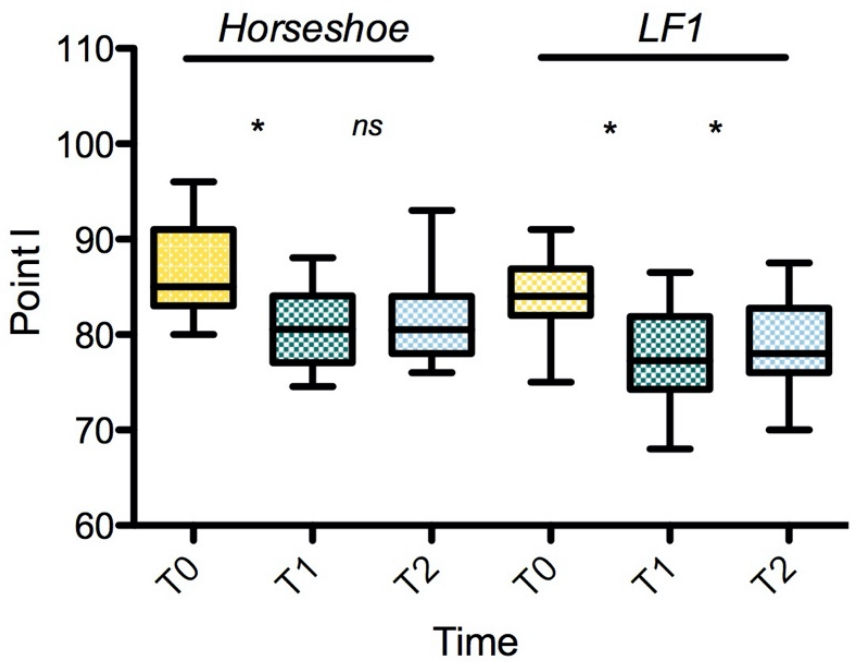

Figure 10. Study of the maxillary stability on point I for the two groups studied. ns, non-significant; LF1, Le Fort I; *, p<0.05.

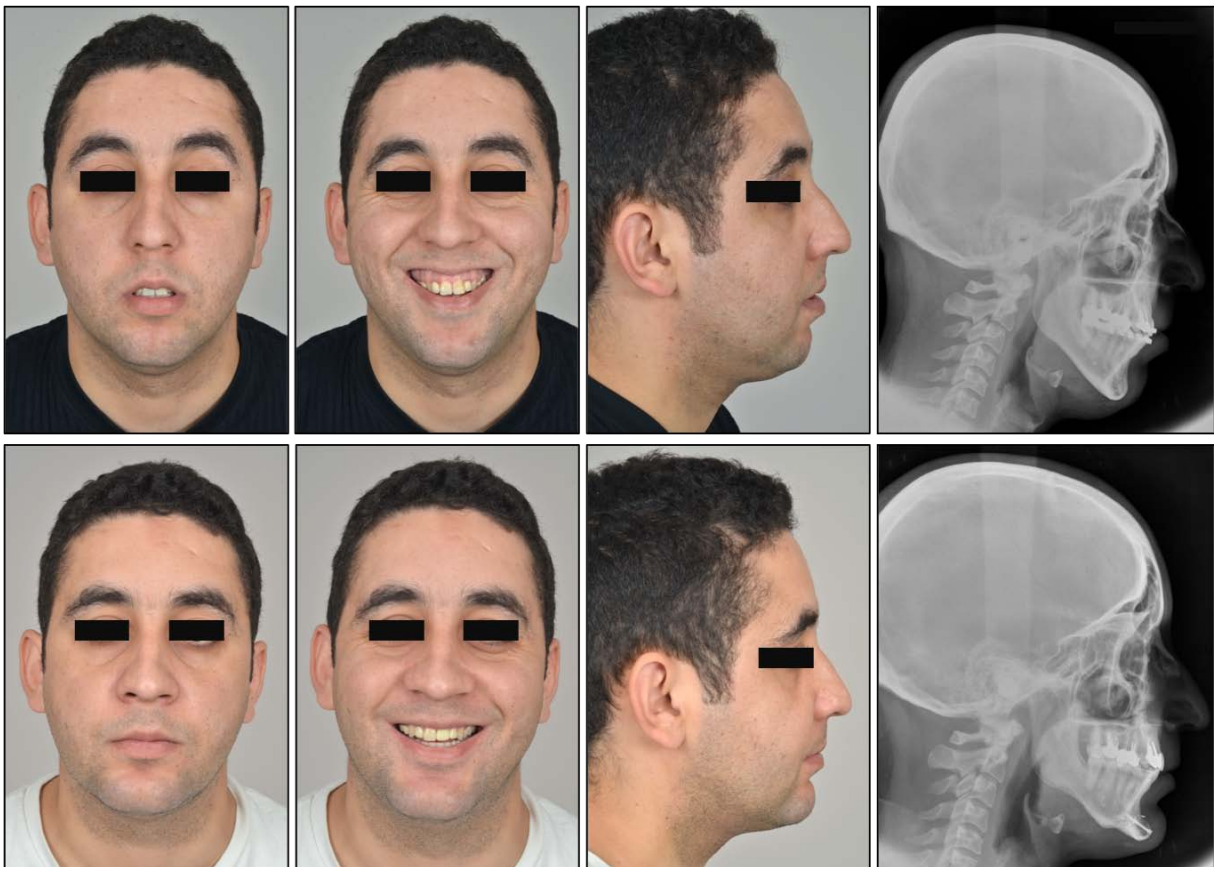

Figure 11. Surgical result obtained with HS osteotomy associated to a genioplasty. Preoperative photographs and lateral cephalograms of the patient (top). Postoperative photographs and lateral cephalograms obtained at one year postoperative (bottom).

The degree of relapse was compared between T1 and T2 in the two groups. We did not find any significant difference regarding the three points C, P and I (p1=0.601, p2=0.519 and p3=0.204 respectively) (figure 12).

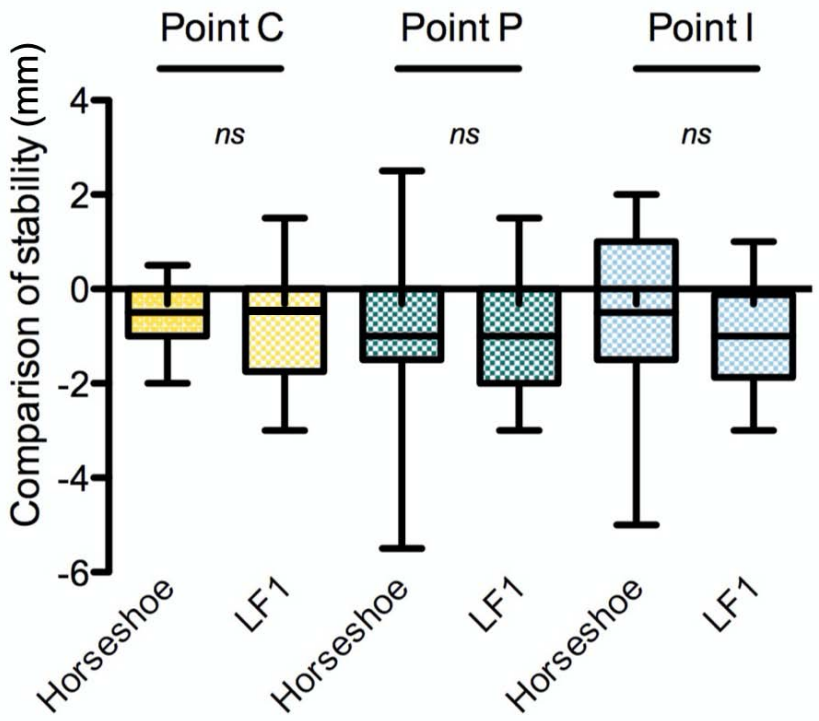

Figure 12. Comparison of the relapse between the two groups for the points C, P and I. ns, non-significant; LF1, Le Fort I.

Smile assessment

Assessment of the smile by observers showed an improvement of +8,8/50 (-1.9/50 to +18.1/50) between the preoperative and the postoperative period in HS osteotomy group.

On gummy smile criteria, we found an overall improvement of +4,1/10 between preoperative and postoperative times (-0,4/10 to +7,6/10).

Data on smile assessment are resumed in table 3.

	Average score T0				Average score T2				Improvement			
Assessors	**MFS**	**OD**	**NP**	**AA**	**MFS**	**OD**	**NP**	**AA**	**MFS**	**OD**	**NP**	**AA**
Criteria (/10)												
GS	3.7	3.6	3.9	3.8	8.5	7.1	7.9	7.9	4.7	3.5	4.0	4.1
OPC	6.3	6.8	5.9	6.2	8.4	8.7	7.5	8.0	2.1	1.9	1.6	1.8
MPC	6.7	7.2	6.3	6.6	8.5	8.4	7.2	7.8	1.7	1.2	0.9	1.2
MIT	6.7	7.5	6.1	6.5	8.4	8.3	7.5	8.0	1.6	0.9	1.5	1.4
BC	5.5	5.9	6.4	6.1	6.6	5.5	6.5	6.3	1.0	-0.4	0.1	0.2
Global (/50)	28.9	31.0	28.6	29.1	40.4	38.0	36.6	38.0	11.5	7.0	8.0	8.7

Table 3. Comparison between preoperative and postoperative average score on each smile criterion in horseshoe osteotomy group. GS, gummy smile; OPC, occlusal plane canting; MPC, maxillary inter-incisors point centering; MIT, maxillary central incisors tilting; BC, black corridors; MFS, maxillofacial surgeon; OD, orthodontist; NP, lay people; AA, all assessors.

Respiratory assessment

Ten patients (67%) in the HS group accepted to answer to the call. All the asked patients declared to be an oral ventilator in the preoperative period. Only four patients were still oral ventilator in postoperative time, but three of them noted an overall improvement. The other six patients were nasal ventilators postoperatively.

Five asked patients presented a preoperative snoring, four of them noted an overall improvement in postoperative period and one patient didn't note any modification. None of the asked patient described a degradation.

Complications

Few complications were identified whatever the surgical technique used. Frequent complications were the malocclusion relapse (four in HS group, two in LF1 group), or inferior labia or chin paresthesia (two in HS group, one in LF1 group, but only with associated SSO), there was no superior labia hypoesthesia/paresthesia. There was also three transitory dysmorphophobias, only in LF1 group, but we didn't identify the reason.

Other complications were noted in the HS group: oral-nasal communication (one patient requiring a new intervention) and palatal wound spontaneously resolving (one patient), non-disabling postoperative temporomandibular disfunction (one patient), infection of the operating site (one patient), and one case of central incisor devitalization probably related to an excess of piriform orifice digging.

A total of six patients presented a complication in LF1 group versus nine patients in HS group (table 4).

	HORSESHOE	LE FORT I
Complications		
Malocclusion relapse, n (%)	4 (27)	2 (10)
Labial/chin paresthesia/anesthesia, n (%)	2 (13)	1 (5)
Dysmorphophobia, n (%)	0	3 (15)
Oral-nasal communication, n (%)	1 (7)	0
Temporomandibular dysfunction, n (%)	1 (7)	0
Operating site infection, n (%)	1 (7)	0
Central incisors devitalization, n (%)	1 (7)	0
Palatal wound, n (%)	1 (7)	0

Table 4. Complications associated to the two surgical procedures. n, number of patients.

DISCUSSION

The maxillary vertical excess or maxillary anterior hyperplasia is poorly described in the literature. Patients with LFS usually present an aesthetic complaint, and suffer from a lip inocclusion at rest, a severe gummy smile and an excess of dental visibility. Some authors proposed to treat the maxillary hyperplasia with an upper lip lengthening with poor results (22). The first LF1 osteotomy was described by Wassmund in 1927 to treat mid-face deformities, and Shushardt in 1943 especially for the correction of posterior maxillary alveolar hyperplasia. This technique was only democratized in the 70's with the works of Wolford, Epker and Bell who described the technique known to date of total maxillary osteotomy (8) (9). In LFS, the application of a classic LF1 osteotomy with great upward movement exposes to an important risk of relapse due to the position of inferior turbinate. For this reason, Bell described a complementary turbinectomy procedure associated with total LF1 osteotomy (10). This procedure was not without consequences and did not correct the deformity which was not a too large volume of turbinates but a small nasal cavity. Hall and Roddy, and also West and McNeill were the first to describe the HS osteotomy technique (11) (12). In this procedure, only the maxillary arch was raised with a total maxillary alveolar ostectomy. The technique used a surgical approach with vestibular and palatal incisions. The authors showed a significant improvement of aesthetic and functional parameters in patients suffering from a LFS with no need for an additional surgical procedure on soft tissues. The main benefits of this technique were previously defined as the possibility for an important maxillary upward movement without reducing the volume of the nasal cavity, the absence of turbinate alteration, and the anatomic correction of the long-face deformity. Another application of the HS osteotomy was founded in the literature for preimplant surgery. A sandwich technique with iliac or costal bone graft was described by Farmand *et al.* in 1992 who showed a significant bone resorption at four years of follow up (13), and by Kaan *et al.* in 2004 who showed that there was less bone resorption when the implants were set up in a second time procedure (14).

Recent studies evaluated a new osteotomy technique using a HS osteotomy combined with a LF1 osteotomy, with two additional paranasal osteotomies between the nasal and the inter-

sinusal-nasal septum. Tominaga *et al.* showed with this technique a good long term stability with 4.4 mm mean upward repositioning of the maxilla (23). Yoshioka *et al.* compared this technique to the total LF1 osteotomy showing no significant relapse with 4.84 mm mean upward movement in HS group versus 2.82 mm in total LF1 osteotomy group (24). Harada *et al.* studied the stability of HS osteotomy without paranasal cut, and showed a less than 0.5 mm relapse at one year postoperatively in six patients with a mean 4.1 mm upward movement (25). Our study is the first to evaluate the HS osteotomy technique as described by Hall and West (11,12), and to compare to a total LF1 osteotomy with important upward movement over 6 mm. The number of included patients and the mean follow-up of 18.3 and 21.3 months make, in our opinion, the originality and value of this study. Analysis of the stability was carried out with a cephalometric study on lateral cephalograms which represent a reliable technique for measurement (26). Furthermore, we used a validated method for measurement as previously described by Marion *et al.* who investigated the long-term stability of LF1 osteotomies in patients with cleft lip/palate (17). The authors showed an increased risk of relapse with the degree of downward movement, but no significance was found regarding the surgical upward movement. Same results were obtained by Ben Rejeb *et al.* in a stability study of inferior maxilla repositioning without bone graft for non-syndromic patients (27).

We have noticed that there was a difference between upward movement evaluated by the surgeon during surgery and measured upward movement on lateral cephalograms, probably due to a viewing bias, or to the fact that the maxillary upward movements were not all equal anteriorly and posteriorly. Although, the osteotomies in this study were not performed using digital planning or intraoperative guidance. We demonstrated the long-term stability of the HS osteotomy technique after a mean upward movement of 6.1mm on the anterior maxillary. On the other hand, the total LF1 osteotomy leaded to a significant relapse of a mean 1mm on the anterior maxillary at last follow-up time. However, there was no significant difference of the mean relapse between the two groups; this can be explained by the small number of patients included in this study. The results of the different studies on HS osteotomy are presented in table 5.

Study	Methodology		n	Upward movement (mm), mean ± SD (min-max)	Relapse (mm), mean ± SD
Harada *et al.*	Lateral cephalograms Points ANS, A, U1		6	4.1 (3.1-4.8)	< 0.5 (**ns**)
Tominaga *et al.*	Lateral cephalograms Points A, B, Po, U1, U6		8	4.4 (2.0-7.0)	0.4 (0-1.0) (**ns**)
Yoshioka *et al.*	Lateral cephalograms	HS	9	4.84 ± 1.49	0.30 ± 0.08 (**ns**)
	Point A	LF1	10	2.82 ± 0.28	0.26 ± 0.10 (**ns**)
Present study	Lateral cephalograms	HS	15	6.1 ± 2.1 (3.-9.5)	0.83 ± 1.74 (**ns**)
	Points C, P, I	LF1	20	6.4 ± 1.4 (4.-9.5)	1 ± 1.192 (*****)

Table 5. Results of the studies about the maxillary stability in HS osteotomy. ns, non-significant; *, p<0.05; n, patients; HS, horseshoe osteotomy; LF1, Le Fort I osteotomy; ANS, anterior nasal spine; U1, upper incisor; Po, Pogonion; U6, upper first molar; C, distal cusp of maxillary first molar; P, the lowest edge of the maxillary alveolus of the central incisor (prosthion); I, upper central incisor edge.

A large part of the patients included in this study presented a Class II dentoskeletal deformity with facial hyperdivergence. Several patients logically received an associated mandibular surgical procedure including an SSO or a RL (6,7). Most of the patients in both groups benefited as well from a vertical reduction genioplasty, due to the lower face excess observed in LFS. The smile assessment presented in this study was subjective as it was evaluated according to aesthetic parameters. Nevertheless, we have collected a large number of evaluations from maxillofacial surgeons and orthodontists but also from lay people to not be biased by our accustomed view. Furthermore, the Kokich criteria for aesthetic smile assessment are a validated method usually used in the literature. The gummy smile seemed to be the determining factor of the smile improvement in the patients with LFS (19). Indeed, the gummy smile represents a permanent symptom in LFS, with no necessarily an oblique occlusal plane or oblique maxillary central incisors, a deviation of maxillary inter-incisors point or black corridors. Despite this, we showed an aesthetic improvement of the smile of patients with the HS osteotomy technique especially, when looking the gummy smile criteria. Other criteria as the lip balance should be considered for the aesthetic assessment in LFS. Considering the breathing function, the nasal ventilation was also improved with the HS osteotomy technique. This may be explained by the vertical expansion of the piriform orifices and so that the increase of the volume of the nasal cavity, and the absence of compression of the nasal

turbinates by hard palate. The nasal ventilation could be better objectified in a prospective study by using preoperative and postoperative rhinomanometry, as previously described for rhinoplasty and septal surgery (28) (29). Patients also tended to have better quality of sleep with less snoring, but this data remains subjective as it was not objectivated by a polysomnography as employed in sleep apnea syndrome. The main advantages and drawbacks of the HS osteotomy are resumed in table 6.

ADVANTAGES	DRAWBACKS
Mid-term stability Aesthetic improvement - Gummy smile vanishing - Good lip occlusion at rest Nasal breathing improvement - Nasal cavity volume preservation - No turbinectomy needed - Harmonization of the shape's palate improving the positioning of the tongue, swallowing and ventilation	Few additional complications than classical total LF1 osteotomy: - Central incisors devitalization - Oral-nasal communication - Palatal wound Limited indications: proper patient selection Increased operating time

Table 6. Advantages and drawbacks of the horseshoe osteotomy technique.

An alternative to the HS osteotomy technique is represented by the total LF1 osteotomy. However, this technique is often limited to a 5 mm upward movement with a high risk of relapse. Indeed, few studies evaluated stability and relapse risk in LF1 osteotomy associated or not to mandibular surgery and most of them didn't exceed a 5 mm upward movement. They didn't found any significant relapse, but for maxillary upward movement of 3 to 4 mm (30,31). Another study showed a maximum 1.2 mm relapse in maxillary upward movement of 5 to 6 mm, but non-significant (32). In two other studies, *Proffit et al*. evaluated at one year postoperative (61 patients) (33) and at five years postoperative (49 patients) (34) maxillary upward movement on points ANS (anterior nasal spine) and A (point of greatest concavity of the maxilla above the root of the maxillary central incisors). The have found a 2 mm relapse

in 6,5% patients at one year (33) and in 25% patients at five years (34). The mean of maxillary upward movement was under 4 mm. Nevertheless, the reliability of points ANS and A used in those studies can be disputed because of postoperative bone remodeling that occurs in the anterior maxillary concavity and on anterior nasal spine in LF1 osteotomy. Vincent *et al.* studied other points to evaluate the relationship between skeletal stability and postoperative dental movements, point P (point of greatest convexity of hard palate), M (corresponding to point C in this study) and I (the same point as this study) (18). They had an upward movement of 4.3 mm for point P, 2.9 mm for point M and 4.3 mm for point I and they have found a relapse of 1 mm for point P, 3 mm for point M and 4 mm for point I. Three of the eighteen patients in this study had an instability of dental occlusion, and they had no skeletal instability, but instability of dental points. They concluded that occlusal instability in patients with maxillary vertical excess requiring maxillary impaction was not related to skeletal instability, but to postoperative alveolar-dental movements.

A concomitant turbinectomy could be proposed with potential complications as hemorrhage, adhesions, infection and septal perforation. Some studies underlined the 20% risk of such complications after turbinectomy (35) (36). Overall, most of authors agree that turbinectomy should be reserved for patients with severe rhinitis unresponsive to other treatments only (37).

Although showing the interest of the HS osteotomy, our study suffers from various limits. First of all is the low number of included patients interfering with the comparison of the two groups. This is due to the limited indication of the technique of HS osteotomy in the general population of patients requiring an orthognathic procedure. For the same reason, the achievement of a prospective study seems complicated. We hypothesize that most of the French department of maxillofacial surgery use a total LF1 osteotomy even for great upward movement with satisfying results. Also, the use of the cephalometric analysis based on Delaire's works represents a good validated technique for the evaluation of maxillary stability (26). We could take advantage of digital tools including intra-oral camera, 3D-planning softwares to better plan the procedure, and to better evaluate the long-term results obtained with maxillary osteotomies (5).

CONCLUSION

Horseshoe osteotomy technique seems to be a good alternative to the total Le Fort I osteotomy for the treatment of great vertical excess from maxillary origin in the long face syndrome. This technique seems to be stable over time while a significant relapse is observed in Le Fort I osteotomy with 6 mm or more upward movement. Furthermore, the HS osteotomy improves the smile and the nasal ventilation of treated patients.

CLINICAL CASES

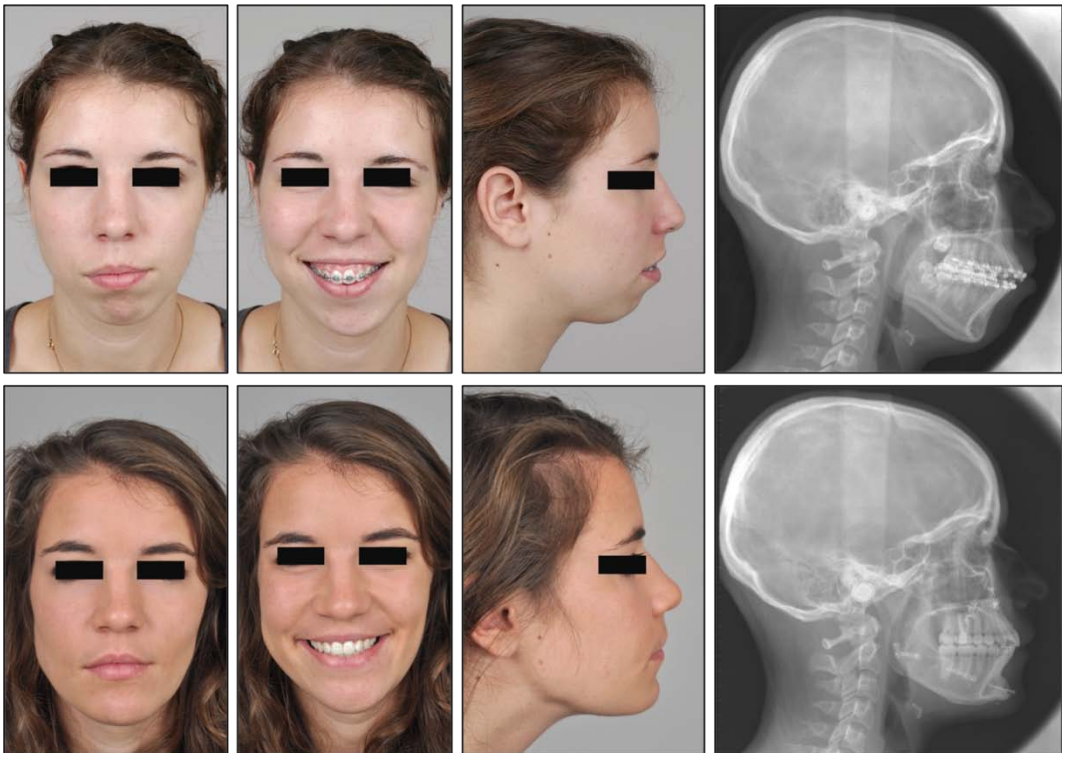

Figure 13. Surgical result. Preoperative photographs and cephalograms (top) and at one-year postoperatively (below) after a Le Fort I osteotomy associated to ramus lengthening and genioplasty.

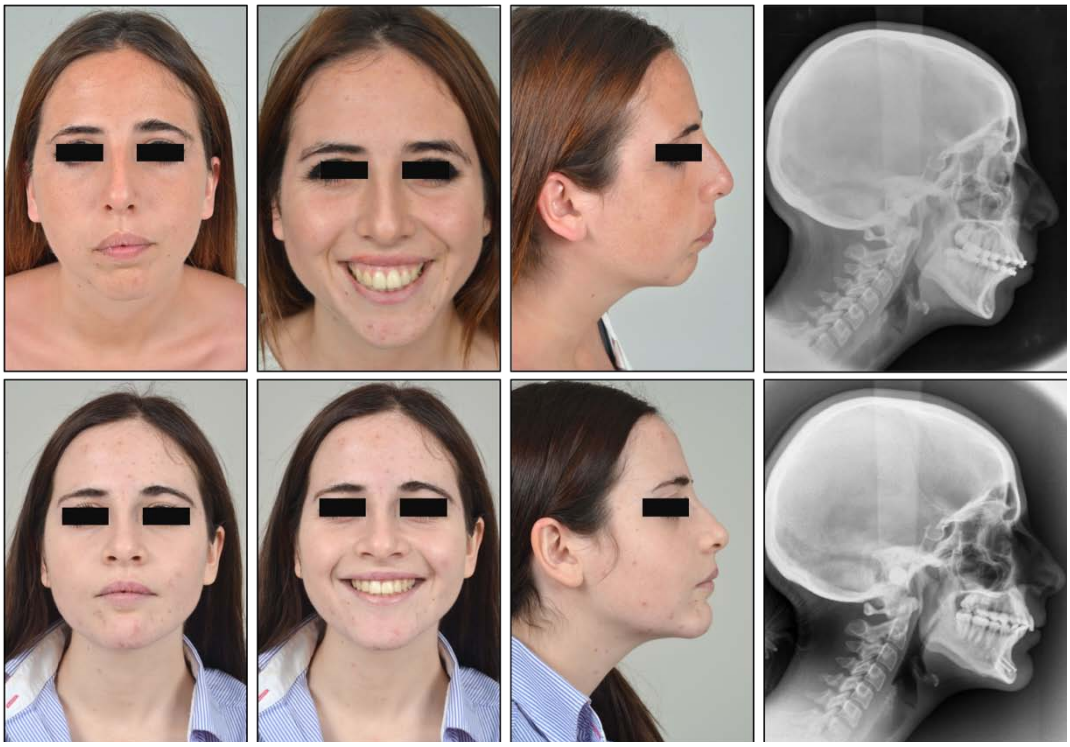

Figure 14. Surgical result. Preoperative photographs and cephalograms (top) and at one-year postoperatively (below) after a horseshoe osteotomy associated to sagittal split osteotomy and genioplasty.

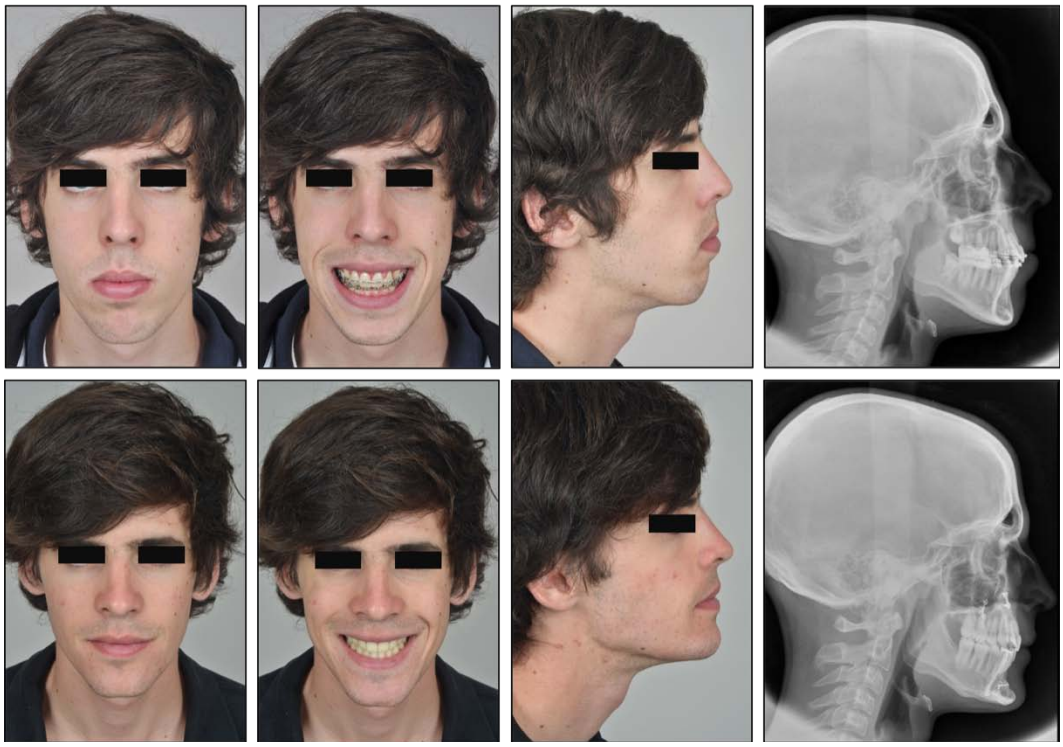

Figure 15. Surgical result. Preoperative photographs and cephalograms (top) and at one-year postoperatively (below) after a horseshoe osteotomy with genioplasty.

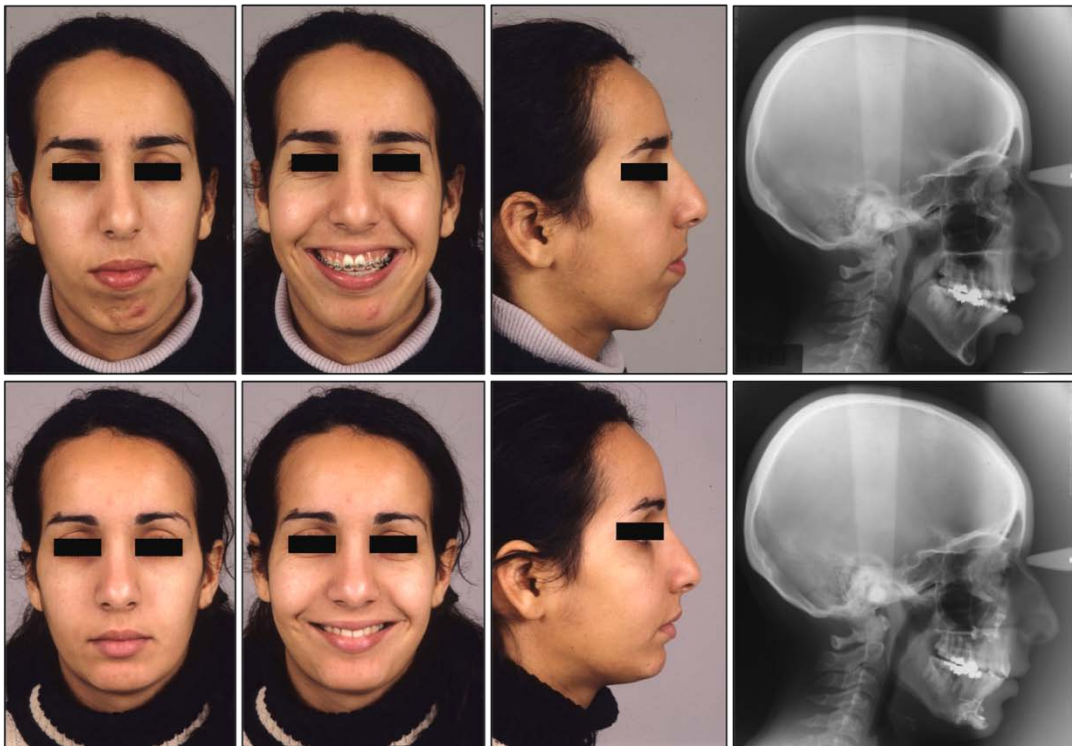

Figure 16. Surgical result. Preoperative photographs and cephalograms (top) and at one-year postoperatively (below) after a horseshoe osteotomy with genioplasty.

UNIVERSITÉ DE NANTES

BIBLIOGRAPHY

1. Schendel SA, Eisenfeld J, Bell WH, Epker BN, Mishelevich DJ. The long face syndrome: vertical maxillary excess. Am J Orthod. 1976 Oct;70(4):398–408.
2. Tourne LP. The long face syndrome and impairment of the nasopharyngeal airway. Angle Orthod. 1990;60(3):167–76.
3. Solow B, Kreiborg S. Soft-tissue stretching: a possible control factor in craniofacial morphogenesis. Scand J Dent Res. 1977 Sep;85(6):505–7.
4. O'Ryan FS, Gallagher DM, LaBanc JP, Epker BN. The relation between nasorespiratory function and dentofacial morphology: a review. Am J Orthod. 1982 Nov;82(5):403–10.
5. Hernández-Alfaro F. [The long face syndrome]. Orthod Fr. 2016 Dec;87(4):479–89.
6. Anquetil M, Mercier J, Leveau S, Mrabet S, Durand T, Salagnac J-M, et al. Evaluation of vertical ramus osteotomy for the surgical correction of unilateral mandibular posterior vertical insufficiency: Long-term follow-up results. J Craniomaxillofac Surg. 2020 Apr;48(4):349–56.
7. Grimaud F, Bertin H, Fauvel F, Corre P, Perrin J-P. Vertical ramus elongation and mandibular advancement by endobuccal approach: Presentation of a new osteotomy technique. J Stomatol Oral Maxillofac Surg. 2017 Feb;118(1):66–9.
8. Wolford L, Epker B. The combined anterior and posterior maxillary osteotomy: a new technique. Journal of Oral Surgery. 1975;33: 842–851.
9. Bell WH. Le Fort I osteotomy for correction of maxillary deformities. Journal of Oral Surgery. 1975 Jun;(33(6):412-26.).
10. Bell WH, Sinn D. Turbinectomy to facilitate superior movement of the maxilla by Le Fort I osteotomy. Journal of Oral Surgery. 1979 Feb;37(2):129-30.
11. Hall HD, Roddy SC. Treatment of maxillary alveolar hyperplasia by total maxillary alveolar osteotomy. J Oral Surg. 1975 Mar;33(3):180–8.
12. West RA, McNeill RW. Maxillary alveolar hyperplasia, diagnosis and treatment planning. Journal of Maxillofacial Surgery. 1975 Jan;3:239–50.
13. Farmand M. Long-term results after horseshoe sandwich osteotomy of the edentulous maxilla as a preprosthetic procedure. Journal of Cranio-Maxillofacial Surgery. 1992 May;20(4):171–7.
14. Yerit KC, Posch M, Guserl U, Turhani D, Schopper C, Wanschitz F, et al. Rehabilitation of the severely atrophied maxilla by horseshoe Le Fort I osteotomy (HLFO). Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2004 Jun;97(6):683–92.
15. Videlaine A, Mercier J-M, Khonsari RH, Corre P. Ostéotomie de Le Fort 1 en fer à cheval. Revue de Stomatologie, de Chirurgie Maxillo-faciale et de Chirurgie Orale. 2013 Nov;114(5):327–30.

16. Nimeskern N, Mercier J-M. [The C0 line: from Delaire's analysis of craniofacial structure to modeling it on a computer spreadsheet]. Rev Stomatol Chir Maxillofac. 2002 Dec;103(6):327–34.

17. Marion F, Mercier JM, Odri G-A, Perrin JP, Longis J, Kün-Darbois J-D, et al. Associated relaps factors in Le Fort I osteotomy. A retrospective study of 54 cases. Journal of Stomatology, Oral and Maxillofacial Surgery. 2019 Nov;120(5):419–27.

18. Vincent C, Mercier JM, Perrin J-P, Khonsari RH. [Stability of Le Fort I impaction osteotomies]. Rev Stomatol Chir Maxillofac. 2012 Apr;113(2):76–80.

19. Kokich VO, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Dent. 1999;11(6):311–24.

20. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. Am J Orthod Dentofacial Orthop. 2006 Aug;130(2):141–51.

21. Geevarghese A, Baskaradoss JK, Alsalem M, Aldahash A, Alfayez W, Alduhaimi T, et al. Perception of general dentists and laypersons towards altered smile aesthetics. J Orthod Sci. 2019;8:14.

22. Ford JF. A plastic operation for lengthening the congenitally short upper lip: preliminary report. J Oral Surg 2:260. 1944 Jul;

23. Tominaga K, Habu M, Iwanaga K, Kodama M, Tsurushima H, Kokuryo S, et al. Maxillary single-jaw surgery combining Le Fort I and modified horseshoe osteotomies for the correction of maxillary excess. International Journal of Oral and Maxillofacial Surgery. 2016 Feb;45(2):194–9.

24. Yoshioka I, Khanal A, Kodama M, Furuta N, Tominaga K. Postoperative skeletal stability and accuracy of a new combined Le Fort I and horseshoe osteotomy for superior repositioning of the maxilla. International Journal of Oral and Maxillofacial Surgery. 2009 Dec;38(12):1250–5.

25. Harada K. Post-operative stability of the maxilla treated with Le Fort I and horseshoe osteotomies in bimaxillary surgery. The European Journal of Orthodontics. 2002 Oct 1;24(5):471–6.

26. Delaire J, Schendel SA, Tulasne JF. An architectural and structural craniofacial analysis: a new lateral cephalometric analysis. Oral Surg Oral Med Oral Pathol. 1981 Sep;52(3):226–38.

27. Ben Rejeb M, Bertin H, Souissi MA, Perrin J-P, Longis J, Searight F, et al. Radio-clinical stability after inferior maxillary repositioning with no interposition graft: A retrospective study of 17 cases. Journal of Stomatology, Oral and Maxillofacial Surgery. 2019 Jun;120(3):224–8.

28. Tombu S, Daele J, Lefebvre P. Rhinomanometry and acoustic rhinometry in rhinoplasty. B-ENT. 2010;6 Suppl 15:3–11.

29. Vogt K, Zhang L. Airway assessment by four-phase rhinomanometry in septal surgery. Curr Opin Otolaryngol Head Neck Surg. 2012 Feb;20(1):33–9.

30. Emshoff R, Scheiderbauer A, Gerhard S, Norer B. Stability after rigid fixation of simultaneous maxillary impaction and mandibular advancement osteotomies. Int J Oral Maxillofac Surg. 2003 Apr;32(2):137–42.

31. Arpornmaeklong P, Shand JM, Heggie AA. Skeletal stability following maxillary impaction and mandibular advancement. Int J Oral Maxillofac Surg. 2004 Oct;33(7):656–63.

32. Venkategowda PRH, Prakash AT, Roy ET, Shetty KS, Thakkar S, Maurya R. Stability of Vertical, Horizontal and Angular Parameters Following Superior Repositioning of Maxilla by Le Fort I Osteotomy: A Cephalometric Study. J Clin Diagn Res. 2017 Jan;11(1):ZC10–4.

33. Proffit WR, Phillips C, Turvey TA. Stability following superior repositioning of the maxilla by LeFort I osteotomy. Am J Orthod Dentofacial Orthop. 1987 Aug;92(2):151–61.

34. Bailey LJ, Phillips C, Proffit WR, Turvey TA. Stability following superior repositioning of the maxilla by Le Fort I osteotomy: five-year follow-up. Int J Adult Orthodon Orthognath Surg. 1994;9(3):163–73.

35. Dawes PJ. The early complications of inferior turbinectomy. J Laryngol Otol. 1987 Nov;101(11):1136–9.

36. Oburra HO. Complications following bilateral turbinectomy. East Afr Med J. 1995 Feb;72(2):101–2.

37. Oluwole M, Mills RP. An audit of the early complications of turbinectomy. Ann R Coll Surg Engl. 1994 Sep;76(5):339–41.

UNIVERSITÉ DE NANTES

Vu, le Président du Jury,

Professeur Pierre CORRE

Vu, le Directeur de Thèse,

Docteur Hélios BERTIN

Vu, le Doyen de la Faculté,

Professeur Pascale JOLLIET

UNIVERSITÉ DE NANTES

NOM : GOGUET PRENOM : Quentin

Titre de Thèse : Stabilité des grands excès verticaux maxillaires antérieurs. Faut-il préférer l'ostéotomie maxillaire totale ou en fer à cheval ?

RESUME

INTRODUCTION. La stabilité verticale du maxillaire après ostéotomie totale de Lefort I d'ascension peut être mise en péril par la réduction du volume des fosses nasales. Il existe alors un risque de détérioration de l'équilibre facial obtenu. L'ostéotomie de Lefort I en fer à cheval représente une alternative à l'ostéotomie maxillaire totale car elle permet de préserver le volume des fosses nasales tout en harmonisant la forme du palais osseux. Le but de notre étude était de comparer la stabilité maxillaire postopératoire après réalisation de ces deux techniques d'ascension maxillaire. **MATERIEL ET METHODES**. La stabilité du maxillaire a été évaluée rétrospectivement dans deux groupes de patients ayant bénéficié soit de la technique classique d'ostéotomie totale de Lefort I (n=20) soit d'une ostéotomie en fer à cheval (n=15) pour une ascension maxillaire de 6 mm ou plus. La stabilité verticale a été évaluée sur téléradiographies de profil réalisées en préopératoire, en postopératoire immédiat et à lors du dernier suivi. Une mesure de la position des points C (cuspide distale de la première molaire maxillaire), P (prosthion, le point le plus bas de l'os alvéolaire sur l'incisive centrale maxillaire) et I (bord inférieur de l'incisive centrale maxillaire) a été réalisée sur un repère orthonormé. **RÉSULTATS**. Les deux groupes étaient comparables du point de vue de l'âge, des indications chirurgicales, des procédures associées et du degré d'impaction du maxillaire. La récidive moyenne pour un suivi maximal moyen de 18.3 et 21.3 mois respectivement pour les groupes fer à cheval et ostéotomie totale de Lefort I était de 0.63 ± 0.77 mm, 0.83 ± 1.75 mm and 0.50 ± 1.75 mm pour les points C, P et I respectivement dans le groupe ostéotomie en fer à cheval, sans différence significative alors qu'une récidive significative de 1.00 ± 1.19 mm et 1.00 ± 1.05 mm a été retrouvée pour les point P (p=0.005) et I (p=0.001) respectivement dans le groupe ostéotomie totale. Cette technique semblait également apporter une amélioration de la ventilation nasale, ainsi qu'une amélioration de l'esthétique du sourire. Les principaux inconvénients de cette ostéotomie sont l'allongement de la durée d'intervention et le risque d'atteinte radiculaire. Il n'y avait pas de différence significative concernant les complications entre les deux groupes. **CONCLUSION.** L'ostéotomie de Lefort I en fer à cheval représente une bonne alternative à l'ostéotomie classique de Lefort I pour les ascensions maxillaires importantes chez les patients présentant un excès vertical antérieur de la face.

MOTS-CLES

Horseshoe osteotomy, Le Fort I osteotomy, maxillary upward movement, long face syndrome