

**Académie d'Orléans –Tours
Université François-Rabelais**

FACULTE DE MEDECINE DE TOURS

Année 2011

Thèse

pour le

DOCTORAT EN MEDECINE

Diplôme d'Etat

Par

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né le 25 avril 1981 Paris IV**

Présentée et soutenue publiquement le 28 octobre 2011

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Introduction

Orthodontists and maxillo-facial surgeons prepare surgical procedures to design well balanced face and functional occlusion characteristics conform to the standards of the Angle Class I. Bony movements and orthodontic planning are well design and literature is plenty of useful guide to provide an optimal outcome (1) (2) (3). This is not the case for soft-tissue and particularly lips. Unpredictable effect of soft-tissue can change an excellent functional result to a poor esthetic outcome. The reciprocal is also true.(4)

The search for a well balanced profile and the search for beauty has become a social necessity. Esthetic judgment is a strictly personal matter and is subjective. Over the last 20 years, survey techniques have it made it possible for researchers to estimate the levels of social appreciation of esthetics(5) (6), not just individual but the average social esthetic judgment of a group.

The importance of the social judgment assigned to an individual is accentuated by the behavioral component that society associates with appearance(7). It is, therefore, important to determine with lips what may be considered well-balanced references.

Sementicly, the beautiful imparts, as soon as it is perceived by the senses, a sensation of well-being or of pleasure; esthetics deals with the notion of the beautiful. The use of a jury assessing the impact of any bony movement on facial appearance changes the aim of a study from the facial form to esthetics. This esthetic judgment or esthetic appreciation is mediated by a judgment formed by a subject on an object :

- Upon the object with its objective makeup and its subjective parameters, which are its symbolic nature and the socio-cultural connections it evokes.
- Upon the subjects, with their objective reading of the object's physical parameters and their personal, subjective interpretations which flow from their cultural backgrounds.

If individual esthetic judgment is an aleatory event, a judgment formed by a designated social group is a scientific reality, this assessment can be described as the average social judgment(8).

Standards by which lips are judged beautiful differ among cultures and change with the whims of fashion. Nevertheless, the qualities designating certain mouths as pleasing can be identified(9) (10). Handsome lips are composed of delicate curves and mounds, an interplay of light and shadow. A harmony exists in the relationship of upper to lower lip and with the rest of the face.

Therefore, a study is carried out to know which measurements differ from attractive and non attractive lips on post orthognathic patients.

Material and methods

Subjects

Patients included in this retrospective analysis had orthognathic surgery in 2009 in the department of maxillofacial surgery, University Hospital of Tours.

Surgery was performed by the same surgeon but 7 different orthodontists. There was orthodontic treatment before and after surgery. The pre-operative care and one year of cephalometric X-ray were available. Patients with congenital facial clefts and craniofacial deformities were excluded.

During post-operative examination, the patients were invited to attend one photographic session at the University hospital of Tours, Loire valley, France.

The aim of the study was explained and informed consent obtained from each patient.

During this consultation, examination and standardized right profile numerical color photographs were taken using a Nikon D90 (Nikon Corporation TM, Japan) camera with a 50 mm lens and a Nikon SB-900 flashgun. All the pictures were taken against a standardized blue background 'sky blue', RAL 5012. The distance between the photographic equipment components and the subjects was 1 meter to minimized image distortion. Special precautions was used to standardized patient position and reflection of light. The subject were positioned such that the Frankfort plane was horizontal, without glasses and with long hair held back. The lips were lightly closed, neither overly relaxed nor tight(12)(13)(14)(15).

The pictures were reframed with THE GIMP freeware (version 2.6.11, Free Software Foundation, Boston, USA).

Method of measurement

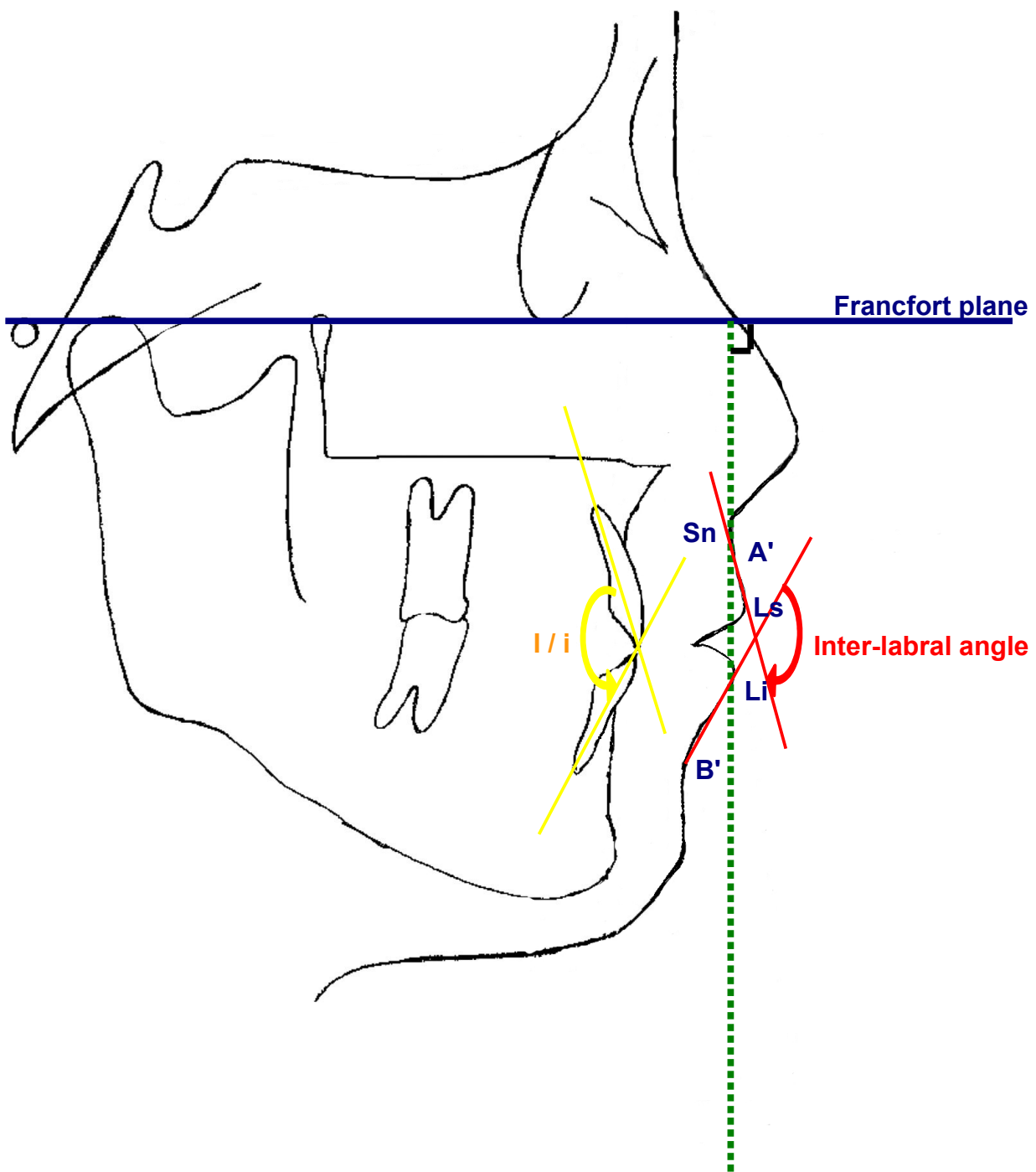
Measurements consisted of establishing landmarks and forming lines that represent the profile. All landmarks are midline structures(16) (17) (18). The landmarks used in this study are shown on figure 1 and 2.

For each subject, data were compiled for 11 variables that described soft tissue lip position and other seemingly relevant dental and skeletal vertical factors :

- Profile soft tissue measurements in millimeters
 - ➔ **Inter-labial gap** in rest position, is the vertical midline opening between the relaxed upper and lower lips with the mandible at rest position.
 - ➔ **Lips angle**, in degrees, to evaluate the divergency of vermillions (Ls-M-Li)
 - ➔ **Intra-labral angle**, in degrees, to assess the opening of vermillions (Ls-St-Li).
 - ➔ **Vermillion height**
 - Total vermillion height, Ls-Li
 - Upper vermillion height, Ls-St
 - Lower vermillion height, St-Li
- Dental measurements in millimeters
 - ➔ **Overjet**, is the horizontal distance between mandibular and maxillary incisor
- Sagittal cephalographic measurements
 - ➔ **ANB** in degrees
 - ➔ **Inter-incisor angle**, in degrees on the preoperative and post-operative cephalometric profile
 - ➔ **Labial projection** on the Franckfort plane's perpendicular passing through the naso-labial point(19) is preferred to the Burstone «B» line (20), to exclude the chin influence on measurements

- **Inter-labral angle**, in degrees (21), is formed by the line tangent to upper lip from its starting point and its intersection by a tangent to the lower lip from its end point.
- **Ratio of labial thickness**, lip taper as describe by Holdaway is a comparison of two measurements of the thickness of the lips, a ratio under 1 reflects thinness of the lips (22).

Figure 1 :



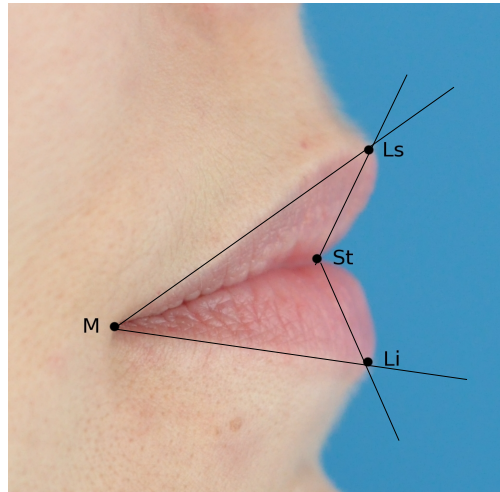


Figure 2a :

Ls-M-Li : Lips Angle

Ls-St-Li : Intra-labral angle

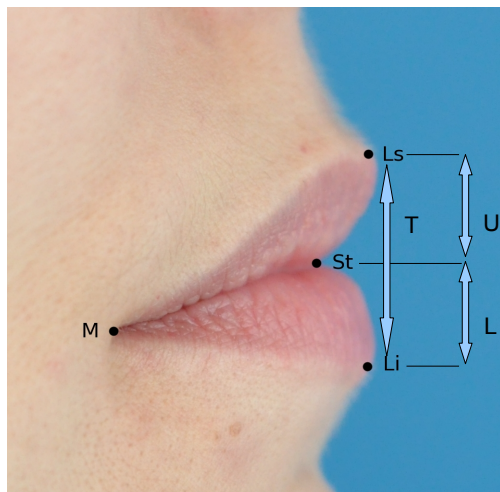


Figure 2b :

T : Total vermillion length

U : Upper vermillion length

L : Lower vermillion length

Esthetic canon

The notion of the average profile differs from person to person and from one racial or ethnic group to another(23). It must be considered a variant depending upon individual, ethnic or racial, and temporal factors (24) (25). Numerous authors described the average attractive position of lips in profile plane or thickness and length (10) (26) (27) (28).

The position of the lips could be evaluated on the convexity line according to Epker and Fish's analysis (sub-nasal vertical line) Figure 1 . This is the distance between the lower lip and the line which gives the ideal position of this lip in relation to this line. The upper lip should be in contact or be situated 2 mm around the vertical. The lower lip should be 2 mm behind the line.

The interlabial gap, which is the vertical distance between the upper lip (upper stomion) and the lower lip (lower stomion), was measured using a sagittal head-film. For competent lips at rest, the opening should measure between 0 and 4 mm ± 2 .

Following Burstone and Farkas measurements(4)(21) (29) , the most attractive value for inter-labial prominence angle is between 120° and 160°.

The total vermillion height is about 16mm(17) (25) (30) , the upper vermillion height 6,7 to 7,2 mm and lower 8,8 to 9,3 mm, with no difference in sex.

Assessors

Three panels of judges were invited to participate in the grading procedure. The first group comprised two clinicians specializing in orthodontics. The second comprised two maxillo-facial surgeons and the third two lay persons.

Each assessor worked independently using a Visual Analogic Scale (VAS) to mark each picture.

Statistical methods

The photographic display boards were scored according to the VAS mark (0-10) as continuously variable.

Pearson correlation coefficients were performed between the average mark and every photographic and cephalometric measurements.

The average measurements of the ten most attractive lips were compared to the ten less attractive lips with student test (p value of 0.05 considered as significant). The mean measurements of the ten most attractive was used as referent value. The absolute value of the variation of these value were test with the average marks.

The data were analyzed by using OpenOffice Freeware (version 3.3.0, OpenOffice.org by Oracle)

Measurement reliability or Methodological error

Measurement error was calculated using the double-determination method. Two linear measurements and one angular measurement were retaken on 30 subjects by the same investigator. The error analysis, calculating the differences between two determinations, the mean difference, and the standard error for a single determination, was consistent with expectations.

Single Intra class Correlation were performed for all subjects for ANB and inter-incisor angle and showed a high level of agreement.

Results

Ninety-one patients were contacted by letter and phone calls. Forty-nine were reviewed. Five did not have follow-up x-ray, One had mandibular congenital disorders and one was mugged (fractured mandible). The average age was 24 years . The average follow-up was 14,5 months. Thirty-three patients were Class II and 8 were Class III. Mandibular osteotomy was performed in 32 cases, bi-maxillary surgery in 8 cases and lefort I surgery alone in 1 case. Thirteen patients had genioplasty, no alar base cinch stitch was performed.

The facial measurements are summarized in Table 1. There is no significant difference between the assessors marks (orthodontists, surgeons and lay persons).

Table 1 : Mean measurements standard deviation

Facial Measurements	All Subjects		Male	Female	Significance Student test 95 %	M vs F
	Mean	SD				
I/i T2	129,6	8,7	130,4	129,2	NS	
Overjet variation	1,23	0,8	1,18	0,91	NS	
Upper Lip position	1,3	2,1	0,71	1,65	NS	
Lower Lip position	-0,8	3,4	-0,56	-1,32	NS	
Interlabial Gap	1,5	0,8	1,46	1,48	NS	
Intra-labral angle	89,7	16,3	78,7	95,41	P<0,001	
Inter-labral angle	134,1	15,2	139,3	131,5	NS	
Upper lip thickness ratio	0,86	0,14	0,85	0,88	NS	
Lower lip thickness ratio	1,09	0,14	1,13	1,07	NS	
Total vermillion lenght	14,9	2,8	15,9	14,41	NS	
Upper vermillion lenght	6,6	1,5	7,0	6,4	NS	
Lower vermillion lenght	7,7	1,7	8,31	7,41	NS	
Lips angle	45	9,2	48	43,5	NS	
Lips marks	4,2	1,5	3,84	4,37	NS	
Profile marks	4,3	1,5	4,7	4	NS	

The correlation between the measurements and the subjective marks is shown in Table 2.

The Pearson's correlation test was used with 95% confidence interval statistics.

Table 2 : Correlation between measurements and assessors marks

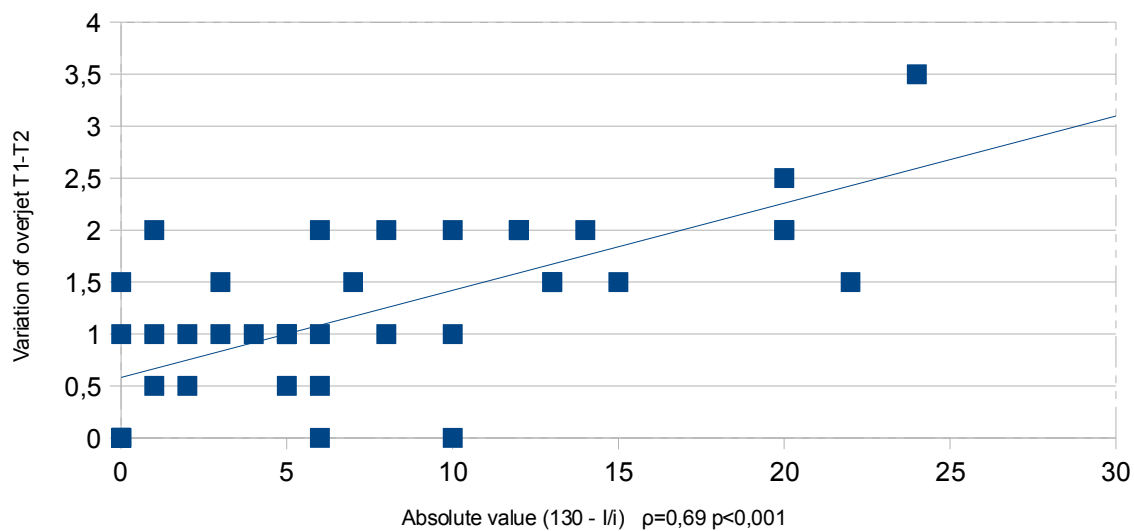
Lips	Inter-incisor angle T2		Lips Position				Inter-labral gap		Intra-labral angle		Inter-labral Angle		Lips thickness		Lips angle		Total Vermilion		Upper vermilion		Lower vermilion	
			superius		inferius				Ls-St-Li		A'-LsB'-Li		Superius				Ls-Li		Ls-St		St-Li	
	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Assessor 1	0,249	NS	0,258	NS	-0,061	NS	0,114	<0,05	0,079	NS	-0,338	NS	0,280	NS	-0,035	NS	0,093	NS	0,271	<0,05	-0,068	NS
Assessor 2	0,192	NS	-0,288	NS	-0,192	NS	0,088	NS	0,224	<0,05	-0,150	NS	0,061	NS	0,095	NS	0,091	NS	0,273	<0,05	0,009	NS
Assessor 3	0,460	NS	0,146	NS	-0,007	NS	0,119	NS	0,324	NS	0,308	NS	0,296	NS	0,339	NS	-0,085	NS	0,130	NS	-0,060	NS
Assessor 4	0,426	NS	-0,129	NS	0,052	NS	-0,469	NS	0,247	NS	-0,269	NS	0,340	NS	0,375	NS	0,320	NS	0,403	<0,05	0,325	<0,05
Assessor 5	-0,169	NS	-0,216	NS	-0,404	NS	-0,006	NS	0,157	NS	0,324	NS	-0,381	NS	-0,451	NS	0,200	NS	0,195	NS	0,261	NS
Assessor 6	-0,103	NS	0,105	NS	0,179	NS	-0,230	NS	0,072	<0,05	-0,071	NS	-0,193	NS	-0,059	NS	0,106	NS	0,233	<0,05	0,290	NS
Average Mark	-0,093	NS	0,136	NS	0,064	NS	0,162	NS	0,226	<0,05	-0,093	NS	-0,017	NS	0,132	NS	0,144	NS	0,325	<0,05	0,135	NS

Profil																						
	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Assessor 1	0,067	NS	-0,006	NS	-0,018	NS	-0,163	NS	-0,109	NS	0,429	NS	0,024	NS	-0,388	NS	0,417	NS	0,369	NS	0,280	NS
Assessor 2	-0,023	NS	-0,636	<0,05	-0,303	<0,05	-0,126	NS	0,143	NS	0,038	NS	0,034	NS	0,196	<0,05	0,251	NS	-0,017	NS	0,289	NS
Assessor 3	0,196	NS	0,015	NS	0,206	NS	-0,398	<0,05	0,244	NS	0,077	NS	0,070	NS	-0,087	NS	0,090	NS	0,013	NS	0,219	NS
Assessor 4	-0,113	NS	-0,014	NS	0,088	NS	-0,326	NS	0,059	NS	0,478	NS	-0,166	NS	-0,314	NS	0,549	NS	0,209	NS	0,377	NS
Assessor 5	0,117	NS	-0,239	NS	-0,255	NS	-0,353	<0,05	0,007	NS	0,166	NS	0,119	NS	-0,036	NS	-0,003	NS	-0,190	NS	0,112	NS
Assessor 6	0,304	NS	-0,150	NS	-0,059	NS	-0,243	<0,05	0,204	NS	0,305	NS	0,314	NS	0,289	NS	0,155	NS	-0,012	NS	0,263	NS
Average Mark	-0,007	NS	-0,107	NS	-0,078	NS	-0,253	<0,05	0,324	NS	-0,004	NS	0,037	NS	0,143	NS	0,283	NS	0,057	NS	0,310	NS

Abbreviations : NS, non significant. p : Pearson's product-moment correlation; Alternative :two.sided 95%

This study shows a high level of correlation ($\rho=0,69$, $p<0,001$) between the variation of overjet and the variation of inter-incisor angle to 130° (which is considered as the reference angle). Figure 3

Figure 3 : Variation of Overjet I/i between T1 and T2



A middle-high correlation was found between the variation of lips angle to 49° (absolute value) and average marks of lips ($\rho=-0,425$, $p<0,005$).

A very low correlation was found between average marks of lips and the entire profile ($\rho=0,226$, $p<0,1$).

A low correlation was found between intra-labiale angle ($\rho=0,222$, $p<0,05$), upper vermilion height ($\rho=0,324$, $p<0,05$) and average mark of lips. The average marks of a different surgery procedure were compared as extraction status and initial diagnosis (student test). Only average marks of the non extraction group (4,48) were significantly higher ($p<0,005$) than non extraction (3,13). Results are shown in Table 3.

Table 3: Mean marks and subgroup

Subgroup	N	Mean $\pm$ SD	student test 95%
Male	14	3,8 $\pm$ 0,5	NS
Female	35	4,4 $\pm$ 1,5	
Extraction	9	3,13 $\pm$ 1	P<0,01
Non-extraction	32	4,3 $\pm$ 1,5	
Class II	33	4,23 $\pm$ 1,5	NS
Class III	8	4,5 $\pm$ 1,3	
Bimaxillary surgery	9	4,7 $\pm$ 1,8	NS
Mandibular osteotomy	31	4,1 $\pm$ 1,5	

Two groups were created and compared - the ten most and the ten least attractive lips (average mark 6,3 versus 2,4 $p<0,001$). The intra-labral angle (Ls-St-Li) of 95° versus 82° ($p<0,05$), lips angle of 49° versus 40° ($p<0,05$), total vermillion length (Ls-Li) of 16,2 versus 14,2 ($p<0,05$) and upper vermillion (Ls-St) length of 7,5 mm versus 6,3 mm ($p<0,05$) were significantly different. Results are shown in Table 4.

Table 4 : Comparison between the ten most and the ten least attractive

	The ten most attractive	The ten least attractive	student test 95%
Assessors Marks	6,3 $\pm$ 0,8	2,4 $\pm$ 0,3	<0,0001
Intra-labral Angle	94,9° $\pm$ 9,4	82,2° $\pm$ 8,9	<0,05
Lips Angle	49,1° $\pm$ 3	40,3° $\pm$ 7	<0,05
Red Lips length	16,2mm $\pm$ 1,53	14,2mm $\pm$ 1,57	<0,05
Upper Vermillion	7,5mm $\pm$ 1,33	6,3mm $\pm$ 0,9	<0,05

Lips angle of 49°, inter-labral angle of 94° and height of 9 mm for upper vermillion are the best value for an attractive lips on this sample. The absolute value of the variation of these value were test with the average marks (figure 4 to 6) and a medium correlation was found.

Figure 4 : Variation of upper vermillion lenght

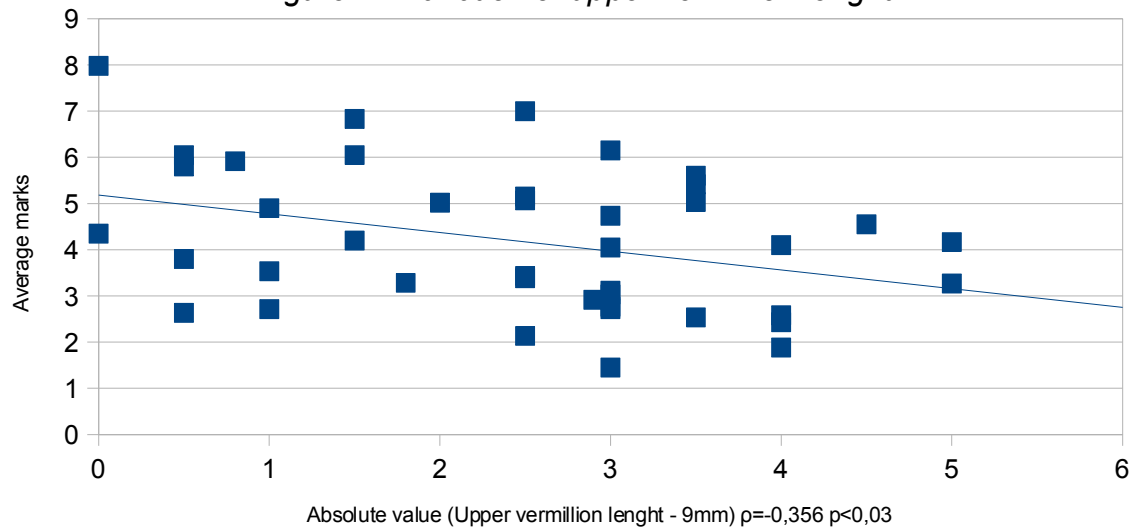


Figure 5 : Variation of intra-labral angle

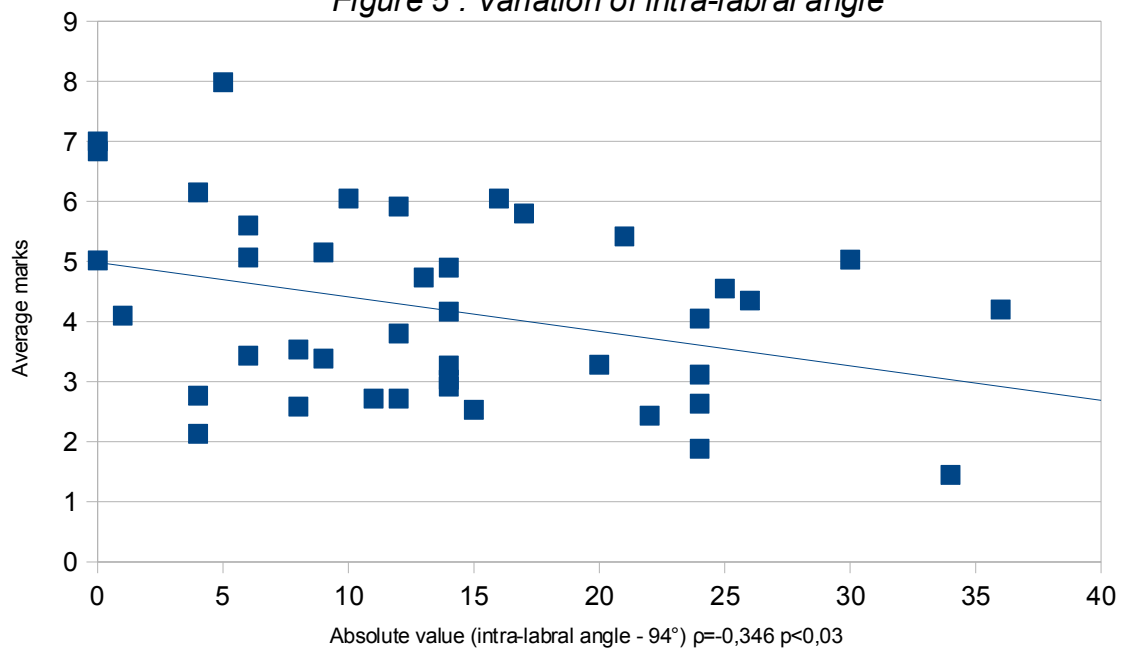
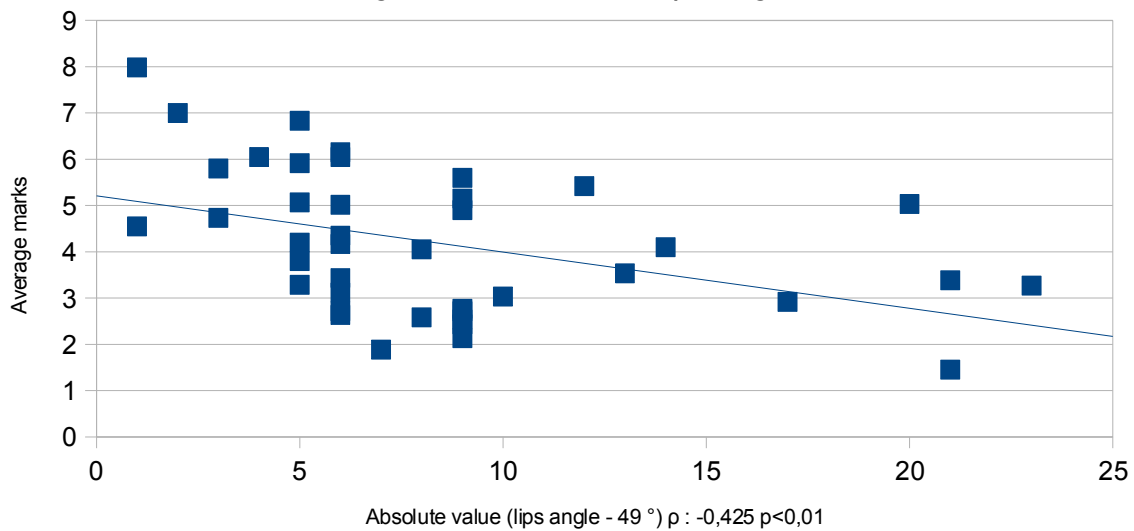


Figure 6 : Variation of lips angle



Discussion

The results of this study confirm a link between measurements and lips attractiveness. Lips angle of 49°, inter-labral angle of 94° and height of 9 mm for upper vermillion seem to enhance the beauty of lips on profile. A strong correlation between a preoperative inter-incisor angle of 130° and the long term stability of the overjet (Figure 3). This « ideal » preoperative data seems to have no impact on the esthetic of the lips on this sample of patient ($p=-0,093$, $p=0,563$, IC 95%[-0.3893 ; 0.2212]).

Many artists, surgeons or othodontists have proposed evaluation of facial esthetics(5) (26) (31) (32) (33) (34). But few have made clinical measurements of a large number of people with large proportion of ethnicities to develop guidelines for a scientific facial esthetic evaluation. Only Farkas explored more than 155 proportions; just 14 was significant(28) (29).

The soft tissue analysis is described to aid the clinician in the treatment plan. The objectives of orthodontics and orthognathic surgery are multifarious and involve better facial esthetics, dental arch relationships and oro-facial praxia. But an assessment of facial appearance, by conformity to the lip/profile relationship dictated by the esthetic lines of differents authors (Ricketts, Steiner or the Z of Merrifield) could be arbitrary. Even if the criteria correlates significantly with accepted esthetics opinion, it cannot be the only determining parameter. Also, the standards are helpful in planning the surgical procedure, but must be adapted to each patient. The position of the lips can hide a dental relationship and be an inadequate guideline of facial disharmony (18) and the treatment which is based on skeletal standards can result in disharmonious facial proportions (35). The knowledge of the proportion of the lips can provide valuable information for planning orthodontic and surgical corrections in order to improve facial attractiveness.

In this study, the photographs were profile views mounted on a single board. Howells and

Shaw (36) have shown a moderately high correlation between ratings assigned to subjects and photographs of the same subject(37).

To evaluate the lips and profile of the patient, visual analogue scales (VAS) were used by judges for notation. This has many advantages (rapid method, easily understood, readily accepted). Judgments can be expressed by classifications, which are more precise (32). They force the judge to make a decision and the judge cannot stay neutral by giving an average mark. This required a maximum of 20 cases. The use of a VAS ranging between two extremes makes fine and reproducible rulings, defining a quantitative variable (38). It would be useful to use a control group to evaluate the responses of the panel, but the aim was not to evaluate an esthetic variation or compare the patient before and after surgery.

The focus was on « profile esthetics », not because the frontal plane is unimportant, but because the cranio-facial malformations as well as treatment changes are more specific in this plane of space and because we want to focus on the inter-incisor angle which is evaluated on the patient's profile. This cephalometric approach has advantages and disadvantages. Measurements may be taken directly from the living, but this has the disadvantage of diminished precision because of soft-tissue mobility.

The photograph was framed on the lips only and compared after to the entire profile. The response was clear ($p=0,226$, $p<0,005$) - we should never forget that the elements of the face are interdependent not only anatomically and physiologically but also esthetically (17) (39).

Moreover, this study shows that non extraction patients have a more attractive lips on profile. This is confirmed by numerous authors (40) and ratify the place of non extraction treatment in orthognathic surgery. This corroborates the thesis that premolar extraction has a posterior repositioning effect on the maxillary (41), and endows the profile with certain convexity aspect.

In this study the most attractive lips on profile were for an intra-labial angle of about 94° . These measurements could be another guide in the preoperative evaluation and are confirmed by a correlation between intra-labiale angle and average marks on lips picture. No study has to date examined this angle definition.

In the same way, the length of upper vermillion seems to have an impact on the beauty of lips. The average mark decreased the further away the length of upper vermillion was from 9 mm. The same conclusion was expected with the lips angle about of 49° , the level of correlation was higher.

These measurements must be integrated in a global evaluation of the lips. Some measurements are generally admitted as described above

Some distortions must be highlighted. The major portion of this sample are of caucasian ethnicity (as our general patient). There were more women than men. This sexual difference must have an impact on global lip measurements as decribed by Koury and Epker (17). The inter-labral angle is higher for women (Table 1). Secondary, the mean mark of the ten most attractive patients is not 10 but just 6,3. Consequently, these values must not be the only guide, and further study must test measurements (the intra-labral angle, the lips angle and upper vermillion height) to modern canon.

The aim of these lips structural decortication is to identify the qualities designating certain mouths as pleasing and to obtain lips with delicate curves and mounds, an interplay of light and shadow(9) (42)

From the conclusion, an analytical framework was designed and a layer had to be added on patient standardized photograph. This easy to use and didactical tool permitted the clinician to diagnose precisely the corrections necessary for the lips after orthognathic surgery.

The variation of the patient population, and of the orthodontic/surgery procedure suggests

that results can be extended to general population.

Application of these data to both orthognathic surgery and esthetic surgery are significant.

The orthognathic surgery permits the clinician not only to improve on facial esthetics but also to incorporate adjunctive esthetic procedures into the treatment plan. With further study we could design a comparable population with different planning treatment as described below:

- Preoperative orthodontic, with inter-incisor angle to 130°
- Orthognathic surgery procedures, where the exposed lip vermilion measurements are used to plan incision placements during orthognathic procedures as well as the need for V-Y advancements or alar base cinch stitch (43).
- One year after, secondary procedure to remove titanium plates, perform genioplasty, or additionnal esthetic procedure such as lipofilling or cheiloplasty. This could be useful to restore the intra-labial and upper vermilion length (44) (45) (46) to incorporate the lips in the layer.

Orthognathic surgery improved incisor showing in repose and while smiling given good candidates for lip augmentation or correction.

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Thèse n°

20 pages – 4 tableaux – 6 figures

Résumé :

La chirurgie orthognathique par le rétablissement de l'équilibre faciale apporte confort et maintient des praxies oro-faciales. Au delà de l'aspect fonctionnel, le gain esthétique reste une des motivations principales des patients. La difficulté restant de diagnostiquer avec précision quel élément de l'esthétique labial modifier.

Nous avons mené une étude rétrospective portant sur les patients ayant bénéficié d'une chirurgie orthognathique en 2009. L'objectif étant d'établir une corrélation entre l'esthétique labial et les mesures objectives des lèvres.

Quarante et un patients ont été revus, 14 hommes et 27 femmes. L'âge moyen était de 23 ans. Le délai moyen depuis l'intervention a été de 87 semaines. Il y avait 33 patients en classe II et 8 patients en classe III d'Angle.

Un jury, composé d'orthodontistes, de chirurgiens et de profanes, a évalué les photographies labiales de profile à l'aide d'une échelle visuelle analogique. Une relation statistique a été recherchée entre les mesures (photographiques et céphalométriques) et l'évaluation esthétique.

Une relation statistiquement significative est objectivée entre l'angle intra-labiale, l'angle de divergence labiale, la hauteur du vermillon supérieur. Nous retrouvons une relation statistique forte entre la variation du surplomb et l'angle inter-incisif préchirurgical.

Cette étude nous permet de réaffirmer la stabilité à long terme pour un angle inter-incisif préopératoire de 130°. Nous pouvons également définir un angle intra-labiale de 94°, une divergence labiale de 49° et une hauteur du vermillon supérieur de 9 mm, comme des valeurs corrélées à des lèvres plus attractives.

Le planning chirurgical de prise en charges des dysmorphoses dento-squelettiques pourra inclure la restauration de ces mesures pour augmenter le bénéfice esthétique des patients.

Mots clés :

- Esthétique labial
- Chirurgie orthognathique

Jury :

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Date de la soutenance : Présentée et soutenue publiquement le 28 octobre 2011