

Quantitative management of morphological problems of the incisor-canine group

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ABSTRACT

The maxillary incisor-canine group above all, plays a crucial role both in the esthetics of the smile as well as in mastication.

The most frequent morphological problems, agenesis, stunted, or peg-shaped maxillary lateral incisors will hinder the anterior guidance and have an adverse impact on the smile ("fang" shaped teeth, spaces/overlapping teeth, anomalies in size in relation to neighboring teeth).

The satisfactory reconstruction of the upper six anterior teeth requires first and foremost a proportional relationship between the lateral and central incisors and between the upper and lower six front teeth. A study of the esthetic indices (L/C: lateral/central) and functional (I/S: inferior/superior – mandibular anterior teeth/maxillary anterior teeth) can be a decision aid and can measure the effectiveness of different treatments (adding composites, stripping, ceramic cap, single implant-supported crown).

KEY WORDS

*Lateral maxillary incisors,
Stunted teeth,
Peg-shaped teeth,
Arch length discrepancy (ALD)
Anterior Bolton Index (ABI),
Lateral/central esthetic index.*

Problems of number and/or morphology of the front teeth are frequent, and are most often characterized by a discrepancy in the morphology of the maxillary anterior teeth.

The most classic scenario consists of congenitally missing or stunted upper lateral incisors. But this dental deformity is often not isolated; the practitioner will simultaneously see undersized central incisors, impacted

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canines with atypical morphology (spear-shaped, false...) etc.

The diagnosis and the choices of therapy include prosthetic substitutes for the missing or peg-shaped teeth, either by closing the spaces, or by preserving or even (re)opening spaces by using prosthetic devices, or possibly reconstructing the dysmorphic teeth by enlarging them with composite resin or ceramic crowns.

Whatever therapeutic choice the practitioner makes, he will have to manage difficult problems related to arch length discrepancy (ALD). For example, when faced with peg-shaped lateral incisors the first idea is usually to recreate the crowns of the lateral incisors to fill the space that is naturally theirs (assuming that the canines and the central incisors are in perfect anterior class I occlusion). Alas, the central incisors are often also stunted or small, and reconstructing only the laterals will throw off the harmony of the incisor group by making the laterals excessively large in relationship to the central incisors!

The initial decision for treatment and then, management and order of the treatment procedures – orthodontic, coronoplasty, composite recon-

struction, implant-supported prosthesis or bonded bridge, will be based on two types of data:

- Subjective data based on an overall esthetic evaluation by the practitioner which will include the hue, discoloration and possible spotting, status of the tooth surface, transparency of the incisor border, corona morphology and root morphology (the size of the root will inform its anchorage value and the cervical diameter will inform the possibility of making an augmented crown, periodontal context;
- Objective data that are mainly the mesio-distal dimensions of the teeth and especially the relationships between these dimensions.

The goal of this article is to take into consideration the **numerical** criteria involved in the choices and in the management of the treatment of these cases. These data are not intended to be indisputable directives but rather as a diagnostic aid for clinical decision making. The final decision is made by the practitioners after they quantify the problem and evaluate the esthetic context that, in fact, can only be assessed by them.

2 – NUMERICAL CRITERIA

2 – 1 – Anterior occlusion must of course be esthetic and functional

Functional criterion: Anterior Bolton Index

Gnathology has taught us about occlusal dynamics, the recognized

criteria (anterior guidance slope determined by the condylar path: absence of posterior contacts in lateral excursion assured by a group guidance or better still by secure canine guidance).

We tend to forget the primary statistical criteria: a perfect Class I canine, an incisor overjet close to

2 mm in both the anteroposterior direction as well as the vertical direction (overjet and overbite) and incisor inclination (torque) close to normal.

We certainly cannot make a diagnosis based on an examination of the casts, but casts that are perfectly registered in the anterior zone are a necessary prerequisite in order for correct functioning to be possible.

Harmony in size between the upper and lower six front teeth, will make it possible to simultaneously achieve perfect class I canine and ideal incisor overbite. As soon as a relative mandibular excess appears, for example, compensatory maxillary defects spontaneously occur:

- maxillary diastemas;
- overlapping mandibular teeth;
- diminished overjet.

The accepted criterion for evaluation here is, of course, the Anterior Bolton Index (Ra = 6I/6S).

The values found in research literature are:

- Bolton (55 subjects)^{1,2} ; 77.2 (± 1.65);
- Freeman *et al.* (157 subjects)⁵; 77.8 (± 3.07);
- Faure *et al.* (62 subjects)^{3,6,7}; 76.4 (± 2.16).

We will use 77% as a reference value.

2 – 2 – Esthetic criteria: lateral/central relationship

The esthetics of the buccal-dental smile essentially depends, as each of us knows, on the upper 6 front teeth. But in the usual evaluation of the smile, in this case, a head-on view, the canines play a lower-profile role, than the four incisors (they only have a three quarters profile). In the same way, overlapping teeth and spaces would be much more unsightly between centrals and between centrals and laterals rather than between laterals and canines.

If it is assumed that perfect alignment can be obtained and closing the spaces can be achieved, what will differentiate the unsightly from the correct positioning will be the relationship of size between the lateral incisors and the central incisors.

The two extremes for results would be:

- either an obvious major microdontia of the lateral incisor, exceedingly small in relationship to the central;
- or incisors that look like piano keys, in other words, of equal size.

The criterion used is the lateral/central relationship ($R_{LC} = (12 + 22) / (11 + 21)$).

According to Dallow (62 subjects)^{3,7}, the mean value is:

$$R_{LC} = 0.79 (\pm 0.04).$$

3 – USING THE CRITERIA

The numerical criteria will make it possible to first quantify the dysmor-

phia, and next to help determine and quantify therapy.

3 – 1 – The Anterior Bolton Index: functional criterion

The deviation of the patient value in relationship to the reference value plus the thresholds that make up the mean \pm the type deviation will be used to assess the extent of the discrepancy.

When several treatment options are feasible, the Anterior Bolton Index must be calculated for each of the possible options.

For example, in the case of stunted teeth, the dentist can opt for:

- **preserving the stunted teeth 12-22**

$$R_A = \frac{43+42+41+31+32+33}{13+12n+11+21+22n+23}$$

- **substitution of 13-23 for 12-22 and 14-24 for 13-23**

$$R_A = \frac{43+42+41+31+32+33}{14+13+11+21+23+24}$$

The Anterior Bolton Index makes it possible to calculate which "retouching" to make:

– **if the maxillary arch is considered to be correct, it serves as the point of reference:**

I either theoretical or ideal (in relationship to the point of reference S):

$$I_{th} = S \times 0.77.$$

– **Mandibular excess:**

$$E_i = I - I_{th} = I - S \times 0.77.$$

A positive value expresses how much stripping is required;

– **if the mandibular arch is considered to be correct, it serves as the point of reference:**

S either theoretical or ideal (in relationship to the reference I):

$$S_{th} = I/0.77.$$

Maxillary excess:

$$E_s = S - S_{th} = S - I / 0.77.$$

Notice : these two values are different:

$$E_i = -E_s \times 0.77.$$

3 – 2 The lateral/central relationship: esthetic criterion

Once again, the comparison of the index to the mean value, and taking into consideration the standard-deviation can determine the gravity of the discrepancy.

When various options of treatment are feasible, the lateral/central relationship must be calculated for each of them individually and respectively in relation to the others. In cases of stunted teeth, the orthodontist could plan on:

- **preserving the stunted teeth 12-22**

$$R_{L/C} = \frac{12n+22n}{11+21}$$

- **substitution of 13-23 for 12-22 and of 14-24 for 13-23**

$$R_{L/C} = \frac{13+23}{11+21}$$

The lateral/central relationship also requires the calculation of how many "alterations" to perform:

– **if the centrals are to be maintained as is ; they serve as a point of reference:**

Theoretical or ideal L (in relationship to point of reference C):

$$L_{th} = C \times 0.79.$$

– **Excess of the lateral incisors:**

$$E_L = L - L_{th} = L - C \times 0.79.$$

A negative value expresses how much stripping is required.

A positive value expresses the number of spaces to preserve (possibly for a composite filling);

– if the lateral incisors are to be maintained as is, they will serve as a point of reference:

Theoretical or ideal C (in relationship to point of reference L): $C_{th} = L/0.79$.

– Maxillary excess:

$$E_C = C - C_{th} = C - L/0.79.$$

Notice: these two values are different: $E_L = -E_C \times 0.79$.

4 – THE TREATMENT SOLUTIONS

4 – 1 – Management of overall maxillary deficiency / excess (augmented Anterior Bolton Index)

Four solutions are feasible.

- **Reduction in size of the lower incisor-canine group: incisor-canine stripping**

We are limited to 2 to 2.5 mm: 0.2 mm per proximal face, or approximately 2.4 mm on the 6 front teeth.

If the practitioner decides to do stripping, it should be done at the beginning of treatment.

If there is generalized microdontia complicated by ALD or arch length discrepancy (the anterior maxillary group is even smaller than the lower anterior group), then stripping is contra-indicated.

The indication to “sacrifice” a lower incisor can only be considered where there is a mandibular excess greater than 6-7 mm.

- **Reduction of the incisor overbite**

A reduction of the incisor overbite from 2 to 1 mm, decreases the anterior perimeter of the maxillary arch by 2 mm. We may be able to use this decrease in perimeter but we cannot

reduce the overjet any more, to an edge to edge incisor relationship and we never find it feasible to increase the overjet to manage an upper excess for fear of disturbing the anterior guidance.

- **Management of spaces (upper lateral-canine or inter-centrals)**

We find that the management of gaps between lateral and central is mostly a temporary solution, because patients are in no rush to use a prosthetic solution. We have to be cognizant of the fact that when the gaps are no greater than 1.5 mm or 2 mm, they are inconspicuous and only visible from a three quarters view of the smile (usually, when someone smiles at someone else, the person who is smiling is facing the other person). The management of an inter-incisal gap can be maintained for certain cultural and ethnic groups for whom this is acceptable or even preferred.

- **Enlargement of the upper six teeth**

Enlarging the upper six teeth should be avoided whenever possible especially because of the fragility (of the resin composite) and the disfigurement if a prosthetic solution is used (we should remember that we

are generally dealing with adolescent patients for whom prosthetic solutions should be avoided or delayed as long as possible). To the extent that it is possible, decreasing the size of the lower front teeth is preferable.

When performing an enlargement procedure using composites, there are two conflicting imperatives: the dentist should try to treat as few teeth as possible (limiting the risk of composite fracture) and avoiding lateral veneers that are excessively large on certain teeth (generally 12-22), once again in order to not weaken the coronal reconstruction.

To continue this line of thought, when an upper enlargement is the treatment of choice, it is preferable that the practitioner restrict treatment to only the incisor group: when smiling, the canines are not as conspicuous and they are more involved in mastication. When dealing with six front teeth that are significantly undersized, where the defect is most evident on the lateral incisors, the orthodontist must first consider enlarging 12-22 therefore creating lateral central harmony. Then the practitioner, if it is still necessary, should uniformly enlarge the four incisors all the while being very careful not to make the enlargement too big on the laterals and therefore more breakable.

There are also three treatments often recommended by veteran orthodontists which, in our view, do not solve the problem.

- **Closing spaces with orthodontic treatment and accepting a minor class II canine relation**

If a lateral upper/lower relationship has resulted in a minor class II occlu-

sion for example 1.5 mm), so that mesialization of the canines can close a space between the lateral and canine, which can remain or be reconstructed later with composite filler, the occlusion is unstable. After removing the braces, the lateral occlusion will inevitably be shifted in an obvious class I (slight retraction of the upper canine/premolar or slight mandibular protrusion) with of course the risk of random and uncontrollable reopening spaces among the upper six front teeth.

- **Increase in upper incisor torque**

We have shown the lack of effect of additional torque, whereas crowding is determined by the line joining the inter-dental contact points⁴.

- **Increase in upper incisor tipping**

Once again, we have shown the futility of excessive tipping of the front teeth in order "to fill up" space, because there is no substantial increase in the filled space since of course it is not stable⁴.

4 – 2 – Management of lateral deficiency/excess (augmented Anterior Bolton Index)

Re-proportionalizing the laterals in relationship to the centrals can once again go through several different stages:

- enlargement of the laterals;
- reduction of the centrals;
- substitution of the canines for the upper laterals: this will generally result in an inverted disharmony that requires a reduction of the widths of the "pseudo-laterals".

| | | | | | | | |
|--------------------|----------------------|------------|---------------|---------------------|---------------------|------------|-----|
| 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 |
| 6.4 | 7.3 | 4.5 | 7.5 | 7.5 | 4.7 | 7.3 | 6.5 |
| | 43 | 42 | 41 | 31 | 32 | 31 | |
| | 6.6 | 5.4 | 4.9 | 4.9 | 5.5 | 6.6 | |
| | Normal sup. | 38.8 | Substit. sup. | 42.5 | Inf. | 33.9 | |
| Bolton | | 0.0357732 | | Bolton | Normal | 0.87371134 | |
| I/S | | 0.02352941 | | Bolton | Substitution | 0.79764706 | |
| Pathology | Maxillary | | | | | | |
| Ideal | Maxillary | 44.02593 | | Max. excess | Normal | -5.22593 | |
| | | | | | Substitution | -1.52593 | |
| Pathology | Mand. | | | | | | |
| Ideal mind. | Normal | 29.876 | | Mand. excess | Normal | 4.024 | |
| | Substitution | 32.725 | | | Substitution | 1.175 | |
| L.C. | Normal lat. | | 9.2 | L/C | 0.61333333 | | |
| Index | Lat. substit. | | 14.6 | L/C subst | 0.97333333 | | |
| | Centrals | | 15 | | 0.06666667 | | |
| Pathology | Centrals | | | | | | |
| Ideal | Normal | 11.64536 | | Cent.excess | Normal | 3.35464 | |
| central | Substitution | 18.48068 | | | Substitution | -3.48068 | |
| Pathology | Laterals | | | | | | |
| Ideal | Normal | 11.85 | | Lat.excess | Normal | -2.65 | |
| lateral | Substitution | | | | Substitution | 2.75 | |

Table I
Table showing the problem.

The dimensions of the front teeth and the calculation of the indices RL/C and RA, in the hypothetical cases of saving or substituting for 12-22. The deficiencies and excesses of the compared groups are also quantified.

5 – QUANTIFICATION OF PROCEDURES

Improving the two indices is a complex theoretical process given that the incisors are involved differently in the two indices. In our opinion, the priority must be given to the esthetic index ($R_{L/C}$).

Therefore, the first procedure is either the enlargement or reduction of the laterals.

After doing this, the practitioner must evaluate the anterior ALD (R_A) and recalculate by proportionally applied mandibular reduction (stripping on all six front teeth) or once again

by proportionally applied maxillary enlargement, at least of the incisors.

We find the assistance of an Excel® spreadsheet that automatically calculates the indices ($R_{L/C}$ and R_A) along with the necessary corrections either by enlargement or reduction absolutely indispensable.

The table-valued parameters automatically display the indices $R_{L/C}$ and R_A) for both the hypothetical case of substitution and preservation of the stunted teeth.

| | | | | | | | |
|------------------|------------------|----------|---------------|---------------|------------------|------------|-----|
| 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 |
| 1 | 7.3 | 5.9 | 7.5 | 7.5 | 6 | 7.5 | 6.5 |
| | 43 | 42 | 41 | 31 | 32 | 31 | |
| | 6.6 | 5.4 | 4.9 | 4.9 | 5.5 | 6.6 | |
| | Normal sup. | 41.5 | Substit. sup. | 42.5 | Inf. | 33.9 | |
| Bolton | 0.02409639 | | | Bolton | Normal | 0.81686747 | |
| I/S | 0.02352941 | | | Bolton | Substitution | 0.79764706 | |
| Pathology | Maxillary | | | | | | |
| Ideal | Maxillary | 44.02593 | | Max. excess | Normal | -2.52593 | |
| | | | | | Substitution | -1.52593 | |
| Pathology | Mand. | | | | | | |
| Ideal mand. | Normal | 31.955 | | Mand. excess | Normal | 1.945 | |
| | Substitution | 32.725 | | | Substitution | 1.175 | |
| L.C. | Normal lat. | | 11.9 | | L/C | 0.79333333 | |
| Index | Lat. substit. | | 14.6 | | L/C subst | 0.97333333 | |
| | Centrals | | 15 | | | 0.06666667 | |
| Pathology | Centrales | | | | | | |
| Ideal | Normal | 15.06302 | | Cent. excess | Normal | -0.06302 | |
| central | Substitution | 18.48068 | | | Substitution | -3.48068 | |
| Pathology | Laterals | | | | | | |
| Ideal lateral | Normal | 11.85 | | Lat. excess | Normal | 0.05 | |
| | Substitution | | | | Substitution | 2.75 | |

Table II

Harmonization of the L/C has been established by enlargement of 12-22 with values of 5.9 mm to 6 mm. The index RA remains uncorrected.

The spreadsheet quantifies the discrepancy for the esthetic index as well as for the functional Bolton Index, and therefore indicates the morphological correction that is required (grinding and reduction using coronoplasty or the degree of enlargement).

Of course, the corrective procedures involve both the upper/lower

arches: enlargement of the laterals (or reduction of the centrals) then anterior maxillary enlargement or anterior mandibular reduction.

Since the spreadsheet is dynamic, it is immediately possible to evaluate the impact on the indices of a 1 mm enlargement for a lateral incisor for example.

6 – A CLINICAL EXAMPLE SHOWING THE CALCULATIONS

The clinical case analyzed below deals with generalized microdontia (tooth size far below the mean values), with ALD disorder (Tab. I).

- The superior dentition is very small in relationship to the lower teeth.
 - Stunted peg-shape teeth (12-22).
 - Less prominent stunted teeth (11-21).
- Table I deals with this disorder.

The orthodontist has to first decide whether to save or to extract the peg-shaped teeth.

As you can see, the substitution/sacrifice solution is functionally the best (Bolton at 79% as opposed to 87% with no substitution). However, substitution/sacrifice is the worst decision for the L/C relationship.

| | | | | | | | |
|------------------|------------------|----------|---------------|------------------|--------------|------------|-----|
| 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 |
| 6.4 | 7.3 | 6.5 | 8.2 | 8.2 | 6.5 | 7.3 | 6.5 |
| | 43 | 42 | 41 | 31 | 32 | 31 | |
| | 6.6 | 5.4 | 4.9 | 4.9 | 5.5 | 6.6 | |
| | Normal sup. | 44 | Substit. sup. | 43.9 | Inf. | 33.9 | |
| Bolton | 0.02272727 | | | Bolton | Normal | 0.77045455 | |
| I/S | 0.02277904 | | | Bolton | Substitution | 0.77220957 | |
| Pathology | Maxillary | | | | | | |
| Ideal | Maxillary | 44.02593 | | Max. excess | Normal | -0.02593 | |
| | | | | | Substitution | -0.12593 | |
| Pathology | Mand | | | | | | |
| Ideal mand. | Normal | 33.88 | | Mand. excess | Normal | 0.02 | |
| | Substitution | 33.803 | | | Substitution | 0.097 | |
| L.C. | Normal lat. | | 13 | L/C | | 0.79268293 | |
| Index | Lat substit. | | 14.6 | L/C subst | | 0.8902439 | |
| | Centrals | | 16.4 | | 0.06097561 | | |
| Pathology | Centrals | | | | | | |
| Ideal | Normal | 16.4554 | | Cent. excess | Normal | -0.0554 | |
| central | Substitution | 18.48068 | | | Substitution | -2.08068 | |
| Pathology | Laterals | | | | | | |
| Ideal lateral | Normal | 12.956 | | Lat. excess | Normal | 0.044 | |
| | Substitution | | | | Substitution | 1.644 | |

Table III

The normalization of the Bolton Index has been established with composites installed on the incisor group, respecting the value established for the L/C relationship. The orthodontist must enlarge the upper incisor group by 2.52 mm (0.7 mm/central and 0.56 mm/lateral: $0.56/0.71 = 0.79$).

The first therapeutic approach is intended to harmonize the lateral/central relationship: an enlargement of 2.65 mm, (1.325 mm/tooth). 12-22 attain diameters of 5.9 to 6 mm; the Bolton Index has slightly improved from 87% to 81% (Tab. II).

The second approach is intended to harmonize the overall maxillary deficiency in relationship to the lower teeth.

If the practitioner prefers not to use the stripping solution for the mandible, because of generalized stunted teeth, then the incisor group must be enlarged (Tab. III) by proportionally performing the necessary enlargement of 2.52 mm for the L/C = 0.79 relationship. The centrals have a 8.2/8.2 diameter and the laterals 6.5/

6-5 (+0.7 on the centrals and 0.56 on the laterals).

Overall, the centrals were enlarged 0.77 mm, the laterals 1.9 mm; composites will most likely be used on the centrals, whereas on the laterals (depending on the status of the root and its diameter, the shape of the crown, etc), the practitioner can opt for either an implant-supported or teeth-supported prosthetic device or a composite.

The orthodontist might feel inclined to only redo the laterals, but that would require an even more substantial enlargement (in all: 5.2/2 – 2.6 mm per tooth, to comply with Bolton’s functional imperative), which would leave us with teeth that look like “piano keys” (Tab. IV).

| | | | | | | | |
|------------------|------------------|----------|---------------------|------------------|--------------|------------|-----|
| 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 |
| 6.4 | 7.3 | 7.15 | 7.5 | 7.5 | 7.25 | 7.3 | 6.5 |
| | 43 | 42 | 41 | 31 | 32 | 31 | |
| | 6.6 | 5.4 | 4.9 | 4.9 | 5.5 | 6.6 | |
| | Normal sup. | 44 | Substit. sup. | 42.5 | Inf. | 33.9 | |
| Bolton | 0.02272727 | | | Bolton | Normal | 0.77045455 | |
| I/S | 0.02352941 | | | Bolton | Substitution | 0.79764706 | |
| Pathology | Maxillary | | | | | | |
| Ideal | Maxillary | 44.02593 | Max. excess | Normal | -0.02593 | | |
| | | | | Substitution | -1.52593 | | |
| Pathology | Mand | | | | | | |
| Ideal mind. | Normal | 33.88 | Mand. excess | Normal | 0.02 | | |
| | Substitution | 32.725 | | Substitution | 1.175 | | |
| L.C. | Normal lat. | | 14.4 | L/C | 0.96 | | |
| Index | Lat substit. | | 14.6 | L/C subst | 0.97333333 | | |
| | Centrals | | 15 | 0.066666667 | | | |
| Pathology | Centrals | | | | | | |
| Ideal central | Normal | 18.22752 | Cent. excess | Normal | -3.22752 | | |
| | Substitution | 18.48068 | | Substitution | -3.48068 | | |
| Pathology | Laterals | | | | | | |
| Ideal lateral | Normal | 11.85 | Lat. excess | Normal | 2.55 | | |
| | Substitution | | | Substitution | 2.75 | | |

Table IV

A significant procedure solely for 12-22 (implant-supported prosthesis) is impossible: the practitioner would have to enlarge the size of the lateral incisors by 1.25 mm; as a result, the teeth in the maxillary incisor-canine group would be almost identical in size.

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