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Incisor agenesis: paradigm shift A study of an orthodontic population Clinical cases

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ABSTRACT

Our study among an orthodontic population of 1,095 patients indicates that 9% of the subjects have at least one agenesis (3% for maxillary lateral or mandibular central/lateral incisors).

Regarding possible treatments, we evaluated the different solutions from the less invasive to the most invasive: simple space closure, space closure with laminated veneers, space opening with a cantilevered bonded bridge, space opening with implant.

Recent advances in biomimetic dentistry suggest that now is the time for a paradigm shift.

KEY WORDS

Agenesis, incisor, laminated veneer, cantilevered bonded bridge, implant, biomimetism

INTRODUCTION

A study carried out in our office shows that 3 patients in 100 present with at least one congenitally missing incisor (and for the vast majority an agenesis of the maxillary lateral incisor).

Proper management of patients with a congenitally missing incisor amounts to choosing – in consultation with them? – the best possible functional and aesthetic compromise, all with an eye to the long-term result. These choices involve opening or closing the space of the missing tooth. There are numerous criteria to take into account to help in making the decision (Arvystas[2]).

Space closure for the missing maxillary incisor leads invariably to the need of a remodeling of the canine into a lateral

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Figure 1

incisor and the first premolar into a canine[24, 30, 31, 43, 44].

Based on recent findings in the field of dentistry, opening space poses a dilemma when it comes to recommending a solution. The current paradigm leads the practitioner towards choosing an implant[15]. But is this the best solution over the long term? Should we perhaps consider a reliable, long-term alternative? Biomimetic[22] dentistry seems to provide a different answer to this problem that must be examined with the greatest care.

ETIOLOGY OF AGENESIS

Most part of dental agenesis has a genetic origin, caused either by chromosomal defects[17] or by mutations occurring during replication of the chromosomal DNA[7]. A great number of non-Hox genes are implicated in this these phenomena (MSX1[41], PAX9[8], WNT10A[32], etc.) without a formal demonstrated individual role.

METHOD

In this project, we have chosen to study, among our orthodontic population, 1680 consecutive files to determine the prevalence of subjects with at least one congenitally missing tooth (Fig. 1).

We voluntarily excluded missing wisdom teeth as well as patients with a history of extractions of permanent teeth.

The remaining patients must have at least a panoramic radiograph in their orthodontic file. After exclusion, our population consisted in 1,095 patients fulfilling these criteria.

The average age of this population is 152 months, or 12 years and 8 months (SD 3 years and 4 months). The youngest patient is 7 years of age and the oldest 39 years and 8 months.

The division by sex is balanced (831 boys for 849 girls).

RESULTS

Ultimately, our sample consists in 101 patients with at least one congenitally missing tooth or 9.22% of the orthodontic population studied (for a total of 176 congenitally missing teeth).

The ratio by sex is 3 girls for 2 boys (61 girls, 40 boys), results

confirmed for a Caucasian population by Bergström[5], Brooks[11] and Suarez and Spence[23].

The average age for the sample is 152 months or 12 years 8 months (SD 36 months or 3 years).

Here is the distribution of 176 congenitally missing teeth according to their location:

Maxilla	Number	Percentage
Central incisor	0	0
Lateral incisor	53	30.29%
Canine	1	0.57%
First premolar	2	1.14%
Second premolar	28	16%
First molar	0	0
Second molar	0	0

Mandible	Number	Percentage
Central or lateral incisor	13	6.86%
Canine	0	0
First premolar	2	1.14%
Second premolar	72	41.14%
First molar	0	0
Second molar	5	2.85%

These results are practically identical to those obtained by the author[24] in a previous study.

In decreasing order, the most frequent congenitally missing teeth are the mandibular second premolars (41%), the maxillary lateral incisors (30%), the maxillary second premolars (16%), the mandibular incisors (around 7%) . . .

For this article, we will only focus on the missing incisors.

DISCUSSION

The different specialties of dentistry (orthodontics, prosthodontics, aesthetic dentistry and restorative dentistry) must combine their skills to provide patients with congenitally missing teeth the best results possible in terms of aesthetics and function that will last as long as possible. The practitioner must evaluate and propose treatment with the best ratio between the cost/benefit/risk.

Armbruster[1] warns us: the assessment of the final aesthetic result, whatever option considered, remains very subjective and varies from one person to the other (health professional or patient). We must be able to identify the aesthetic expectations of our patients to be able to satisfy them.

We will follow the recommendations of Tirlet and Attal[37] who discuss a therapeutic gradient for the solutions we provide to our patients (Fig. 2).

For the less invasive treatment (with the weakest cost/benefit/risk ratio) to the most binding treatment choice, here are the different solutions that are offered to our patients:

– Simple space closure of the congenitally missing tooth with simple reshaping of the canine

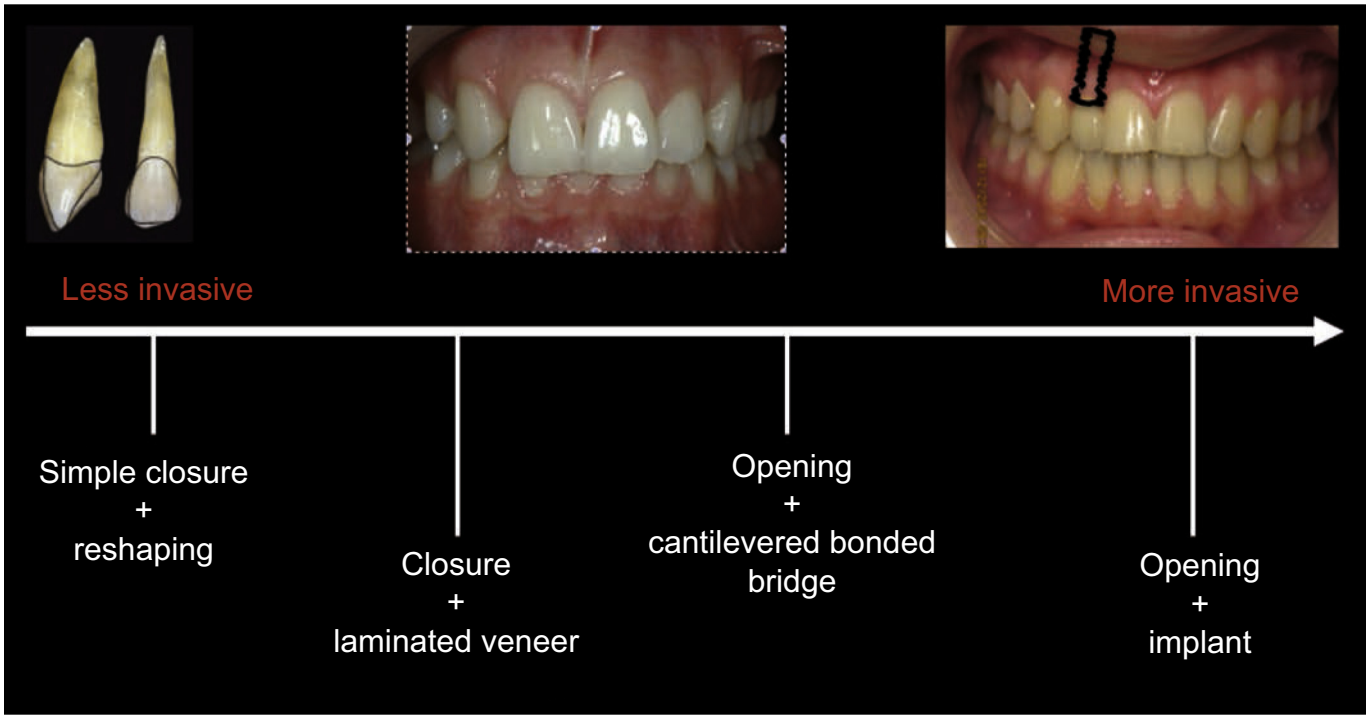

Figure 2
Modified therapeutic gradient (from Tirlet and Attal[32]).

into a lateral incisor (cosmetic reshaping) and of the first premolar into a canine (composite resin build up possible);
- Space closure for the congenitally missing tooth with morphological modification by the use of laminated veneers;
- Opening the space with replacement of the missing incisor with a cantilevered bonded bridge;
- Opening of the space with replacement of the missing incisor with an implant.

Each one of these options must be considered and discussed with our patient to provide him the highest satisfaction.

Numerous factors influence the decision-making[16,24]:

- skeletal (brachy- or dolichofacial):
- vertical excess being favorable for space closure;
- dental:
- occlusal: dental Class III militates for space opening for the congenitally missing tooth even if Ludwig, Zachrisson and Rosa[21], Rosa and Zachrisson[30,31], Zachrisson[43] and Zachrisson, Rosa and Toreskog[44] propose mesialization of the lateral sectors with closure of the anterior space and opening of a posterior space. Obtaining a ''classic'' Class I between the canines does not have to be a dogma. Nordquist and Mc Neill[25] and Robertson and Mohlin[29] have shown that after

space closure for the congenitally missing tooth, leading to a Class I between the maxillary first premolar and the mandibulary canine, the occlusion was perfectly functional over the long-term (no articular dysfunction) and stable from a periodontal point of view;
- – overlaps or diastemas;
- – more specifically, the color, shape, and size of the canine;
- smile line: a gingival (gummy) smile advocates for space closure[43].

We will consider the different possibilities for treatment, by evaluating the advantages and the disadvantages of each solution by beginning with the simplest.

Closure of the space for the congenitally missing tooth

• Simple (without using a prosthesis)

It requires a coronoplasty of the canine into a lateral incisor and of the premolar into a canine. This solution evidently remains the simplest to use as far as it is achievable. It presents, for the patient, the cheapest proposition because it only involves orthodontics and cosmetic remodeling of certain teeth. The most favorable cases are those where the canine is small with a low saturated color, close to the central incisor's one.

The orthodontic treatment should extrude the canine so that it has a collar line as natural as possible. Tuverson[39] and Thordarson and Zachrisson[35] show how grinding the canine is harmless over the long-term, validating the choice of this solution.

Grinding can be completed by the addition of composite resin (a very slightly invasive procedure) in order to perfect the final aesthetic appreciation, composites have the advantage of being able to be renewed easily in case of deterioration of their appearance.

Case number 1 Maureen, 7 years old, with congenitally missing lateral incisors, a Class II right side malocclusion, a right lateral crossbite and a dolichofacial typology. The orthodontic treatment will be divided into two phases.

The first corrective phase for the transverse problem was accomplished with a quad helix over a 6-month period.

The fixed appliances were bonded at 12 years of age after the extraction of the two mandibulary first premolars in order to correct the significant lower anterior crowding. The cosmetic reshaping of the canines was done progressively during treatment to minimize any pulp reactions (Fig. 3 to 12).

• With laminated veneers

The development of aesthetic dentistry, with the concept of biomimetic dentistry introduced by Magne and Belser[22] and relayed to France by authors such as Tirlet[36], Attal[3] and Etienne[15], makes it possible, even indispensible, to integrate laminated veneers into our treatment plans. Manhart[23] and Etiennne[15] describe a detailed approach of the fabrication of these prosthesis and show all the aesthetic benefits they offer. Tirlet and Bazos[38] evoke ''the ceramic/composite resin/enamel-dentin


Figures 3 and 4
First phase of treatment with a quad helix (7 years of age).


Figures 5 and 6
Beginning of fixed appliances treatment (12 years of age).






Figures 7 to 12
End of orthodontic treatment after cosmetic reshaping of the canines and maxillary first premolars.

adhesive complex consisting of components of the natural tissues bio-emulation unit'' with the aesthetic results that imitate Nature.

Laminated veneers streamline treatment plans that include space closure and modifications of the shape and color of certain teeth.

Rosa and Zachrisson[30,31], Ludwig, Zachrisson and Rosa[21], Zachrisson[43], Zachrisson, Rosa and Toreskog[44] show the advantages of this solution over the long-term with the natural evolution of the dentition throughout the ageing process. The final aesthetic result is obtained rapidly as compared to different treatment using implants (they are contraindicated in growing adolescents) in which a removable prosthesis is used for many years.

One of the potential problems of this solution is the tendency for the anterior diastemas to reopen; this unsightly effect can be avoided by using a fixed retention[43].

Case number 2 (courtesy of Dr. Zachrisson) is of a young girl, 14 years old, presenting with a unilateral congenitally missing lateral incisor with a right side dental Class II and an incisor overbite. After the extraction of the left first premolar, the final result was obtained trough the use of laminated veneers on the right maxillary canine and first premolar (Fig. 13a and b).

Opening of the space for the congenitally missing tooth

The most favorable cases are represented by:

- Class I occlusion to dental Class III with small sized teeth;
- the presence of maxillary diastemas and/or mandibular overlapping;
- skeletal brachyfacial typology;
- a smile that reveals little of the maxillary incisors.

• With a cantilevered bonded bridge

Given the enormous progress made over the last few years in the areas of adhesive dentistry and the quality of the ceramics (durability, appearance), we had to consider using aesthetic, biomimetic, bio-emulative dentistry (Magne and Belser[22], Manhart[23], Tirlet and Bazos[38]) in the development of our treatment plans.

In cases in which opening space is the most appropriate issue, this solu-

a b

Figure 13

a) Frontal intraoral view before treatment; b) After orthodontic treatment (Dr. Zachrisson) and placement of laminated veneers on 13 and 14 (Dr. Toreskog).

tion remains much less invasive than using an implant.

A number of studies have demonstrated the stability and the high success rate of cantilevered bonded bridges (with a single abutment) (Attal[13], Attal, Coudray and Tirlet[4], Botelho, Chan, You and Tse[9], Botelho, Leung and Chan[10], Lam, Botelho and McGrath[18], Feilzer and Klevarlaan[40]).

Wong and Botelho[42] show the superiority of the cantilever over the classic bridge (3 units) when subjected to an occlusal load. This argument strongly supports the use of a cantilevered bridge in the incisor-canine area where the occlusal stress is significant.

The quality of the restoration depends on the technical ability of the lab technician (form, color, appearance) to reproduce and to imitate Nature[36].

Lam, Botelho and McGrath[18] and Lam, McGrath and Botelho[19] note that patients do not see any difference between implants and cantilevered bridges in the results obtained. In contrast, they point out that after 5 years, the cantilevered bridges present fewer biological complications than the implants.

Finally, the placement of a cantilevered bonded bridge can be done at the end of orthodontic treatment[36] (even if growth has not ended) and thus avoids the critical phase for the patient of wearing a removable prosthesis.

The behavior of the dental support and the tissues surrounding the cantilevered bridge over ageing is identical to the adjacent teeth.

Case number 3 (courtesy of Dr. Tirlet) shows the perfect aesthetic integration of the cantilevered bonded bridge. This young girl, 14 years of age, presents two congenitally missing maxillary lateral incisors; at the end of the orthodontic treatment, two cantilevered bonded bridges are placed with two chips on the two maxillary canines (Fig. 14 to 19).

Figure 14
After orthodontic treatment (Dr. Beaugrand).

Figure 15
The two cantilevered bridges in Emax ceramic (Esthetic Oral laboratory, Helene et Didier Crescenzo).

Figure 16
Chips on 13 and 23 in Emax ceramic (Esthetic Oral laboratory, Helene et Didier Crescenzo).

Figure 17
Frontal intraoral view of the cantilevered bridges in place (after recontouring (ovalization) of the gingival crest by soft laser).

Figure 18
Occlusal intraoral view of the cantilevered bridges in place.

Figure 19
Frontal intraoral view after 3 years follow up.

• With implant

The elevated rate of long term success mitigates in favor of the use of an implant in the lateral incisor location; the principal advantage remains in the total absence of prosthetic devices on the teeth that border the space of the agenesis.

Mesial eruption of the canine is a bonus; secondary distalization of this tooth leads to a new formation of bone whose dimensional stability (height, thickness), during that time, allows for the placement of the implant without a bone graft[16].

The practitioner should leave at least 1.5 mm on each side of the future implant in order to preserve the interdental papillae.

This present solution however has a number of pitfalls (Rosa and Zachrisson[30, 31]):

- the waiting time between the end of orthodontic treatment during the adolescent period and the ideal moment to place the implant (end of growth), that is 17-18 years of age for a girl and 19-20 years of age for a boy. A temporary removable prosthesis will be necessary but it is sometimes poorly accepted by the adolescent (psychological handicap);
- the risk of root movement (incisor, canine)[27] despite the placement of a bonded retainer on the central incisors and between the canine and first premolar can contraindicate the placement of the implant (Fig. 20 to 22);
- The risk of a progressive bone wasting (horizontal or vertical bone loss);
- The absence of certainty as to the ageing of the implant from a periodontal point (possible appearance of an unaesthetic greyish bordered gingival dehiscence[13], bluish coloration of the gingivae[14]) and mostly occlusal with an similar behavior to an ankylosed tooth (appearance of a difference in the vertical position - ''reintrusion'')[6, 34]. The vertical movement of the

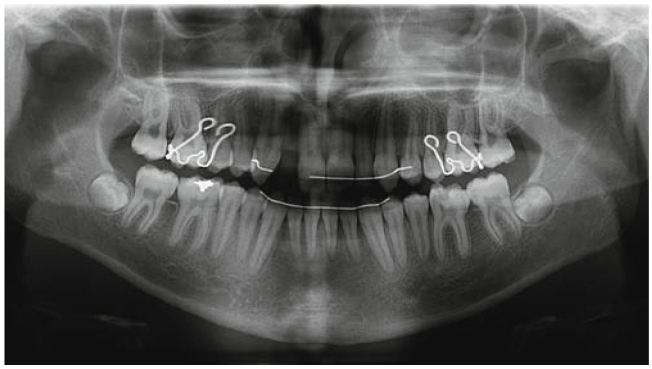

Figure 20
Panoramic radiograph at the end of orthodontic treatment. 11-24 and 13-14 retaining wires are bonded accompanied by a palatal plate to replace 12.

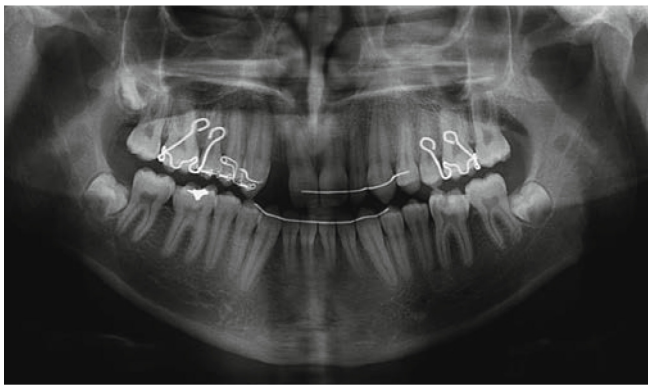

Figure 21
Panoramic radiograph 3 years post retention showing apical displacements (distal 11 and mesial 13) making it impossible to place an implant.

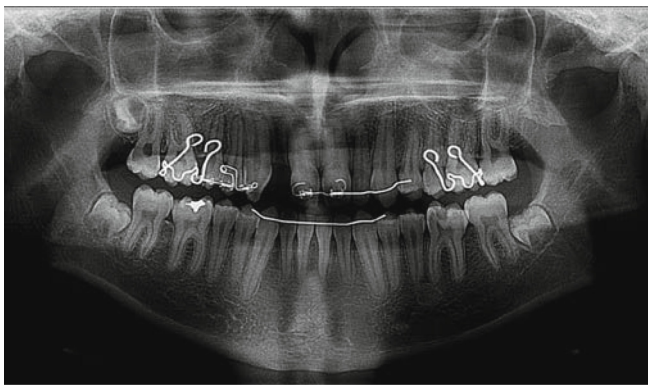

Figure 22
Panoramic radiograph showing orthodontically uprighting of the 13 and 11 (6 months treatment length).

incisors throughout ageing results to a progressive protrusion of the implant (Oesterle and Cronin[26], Thilander, Odman and Lekholm[34]). These authors advise that the patient be warned of these possible aesthetic alterations with ageing, due to changes in the peri-implant environment, requiring modifications of the implant crown (Fig. 23 and 24).

The future certainly appears to be genetic engineering and the possibility to ''create'' a new tooth from stem cells, (Cai *et al*.[28]).

Case number 4 illustrates a satisfactory result, in any case over the short-term, of an implant solution. Meyrine, 14 years of age, presents with congenitally missing maxillary right lateral incisor with a skeletal Class III tendency brachyfacial pattern and a Class I dental pattern with several diastemas. (Fig. 25 to 28).

Figure 23
Implant 12 the day of placement in 2008 in a young girl, 18 years of age.

Figure 24
Five years later, ''intrusion'' of the implant.

Figure 25
Frontal intraoral view before orthodontic treatment.

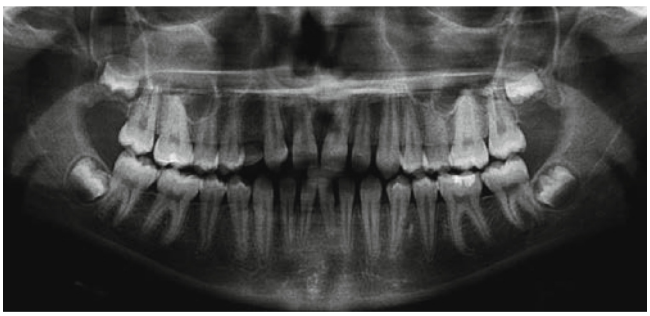

Figure 26
Panoramic radiograph before treatment.

Figure 27
Frontal intraoral view 3 years post retention (implant in place for 2 years, Dr. Bailly).

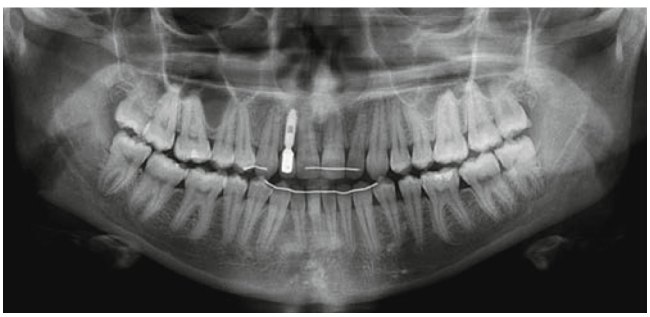

Figure 28
Panoramic radiograph 3 years post-retention.

CONCLUSION

The relatively significant number of patients with at least one congenitally missing incisor (3 patients in 100 in our study) makes each orthodontist ask himself this question: should I open or close the space?

Lehman[20] guides through the process towards making a therapeutic decision.

Tirlet and Attal[37] recommend that we always begin, when it is possible, with the simplest solution, the most economical for the tissues, with the best cost/benefit/risk ratio.

Space closure for the congenitally missing tooth when it is possible, seems to be the most favorable treatment (simple closure with cosmetic recontouring or with application of laminated veneers).

Space opening for the congenitally missing tooth with the placement of an implant can not be considered as a panacea in view of the many questionable events that can occur with ageing that are not controllable in the tissues surrounding the implant.

Biomimetic dentistry, through the cantilevered bonded bridge, brings a long-lasting solution to the replacement of the missing tooth and must absolutely be a part of our therapeutic arsenal.

Finally, works in progress (Cai *et al.*[12], Oshima *et al.*[28]) and yet to come in genetic engineering with stem cells give us great hopes for the creation of ''natural'' teeth substitute.

Conflicts of interest: The author declares no conflict of interest.

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