The B-Mesialslider for non-compliance space closure in cases with missing upper laterals

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In cases with missing maxillary lateral incisors, the two major treatment approaches are space closure and space opening. In many cases, space closure to the mesial seems to be the favourable treatment goal, since treatment already can be completed as soon as the dentition is complete. However, the demands for anchorage are quite high. Both reverse headgear or class III elastics require a high level of compliance and may cause some unwanted side effects such as TMJ problems or retrusion of lower teeth in cases of class III elastics. With the goal to achieve a more reliable anchorage, the use of mini-implants in the palate in combination with a sliding mechanics was introduced (Mesialslider). By adding bonded tubes (B-Mesialslider) premolars can be mesialized bodily without the need of brackets. As a consequence, the time in fixed braces can be significantly reduced or even eliminated. (Semin Orthod 2018; 24:66–82.)

Introduction

Unilateral or bilateral missing upper teeth are diagnosed quite frequently: congenitally missing lateral incisors/second bicuspids, extremely displaced canines or a severe trauma to central incisors are potential findings that result in a reduced upper dentition. The prevalence of missing maxillary lateral incisors especially is quite high (0.8–2%)[1] and thus represents 20% of all congenitally missing teeth.[2] The two major treatment approaches are space closure and space opening to allow prosthodontic replacements either with a fixed prosthesis or single-tooth implant. Both of these treatment approaches may potentially compromise aesthetics, periodontal health, and function.[2] Single-tooth dental implants in the maxillary anterior region have the highest risk of esthetic complications from infra-positioning due to continuing growth and the continuing eruption of adjacent teeth.[3,4] Despite the guidelines summarized by the Angle Society of Europe,[5] there is no broad consensus regarding the optimal treatment plan for patients with missing lateral incisors. However, in many cases, space closure to the mesial seems to be the favourable treatment goal, since treatment already can be completed as soon as the dentition is complete. Thus, a second orthodontic treatment to upright tipped adjacent roots before insertion of a dental implant can be avoided. Canine substitutions can be accomplished with good aesthetic outcomes by tooth reshaping and positioning, bleaching and porcelain veneers.[6–8]

Anchorage requirements for mesialization in the upper arch

The more mesial the missing tooth is the higher will be the demands for anchorage, which can be realized by reverse headgear or class III elastics. However, both anchorage modalities require a high level of compliance and may cause some unwanted side effects such as TMJ problems or retrusion of lower teeth in case of class III elastics. With the goal to achieve a more reliable anchorage, the use of mini-implants has

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1073-8746/12/1801-$30.00/0

https://doi.org/10.1053/j.sodo.2018.01.007

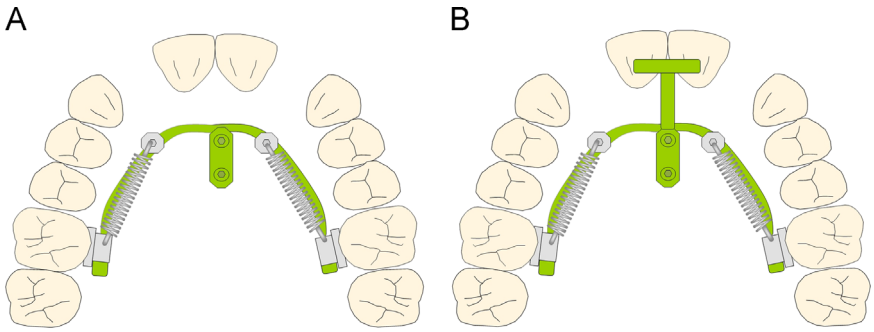

Figure 1. Mesialslider comprising two coupled mini-implants, a Beneplate with 1.1 mm wire in place, two NiTi coil springs, two activation locks and two sliding hooks that are inserted into the lingual sheaths of the molars (A). The T-Mesialslider has an additional connection (T-wire) to stabilize the central incisors (B).

increased over the last couple of years.[9–11] However, buccally inserted mini-implants are in the path of moving teeth. As a consequence, the palatal area seems advantageous, since all teeth can be moved without any interference with TADs.[12,13] Further advantages of the anterior palate are a very good bone quality, a thin attached mucosa, a very low risk of a tooth injury and a very high success rate of around 95–98%.[14–16] If the central incisors are in the correct position (midline, torque and angulation are correct), a rigid wire can be bonded to the lingual surfaces of the central incisors to apply indirect anchorage connected to palatal mini-implants (T-wire).[17–19] The primary goal is to avoid lingual tipping of the central incisors during space closure. As an alternative to the T-wire (indirect anchorage) Wilmes et al. have introduced the Mesialslider[17,18,20] (Fig. 1) as a direct anchorage device. The Mesialslider enables clinicians to mesialize upper molars and thus close upper spaces unilaterally or bilaterally.

By changing the angulation of the guiding wire an additional vertical control can be added, e.g., for correction of open bites by simultaneous molar intrusion and protraction.[21] In addition, even contralateral distalization is possible (Mesial-Distalslider).[22,23] Ludwig et al. have described the use of a combination of direct and indirect anchorage in the palate, the T-Mesialslider (Fig. 1B).[24] As an alternative to the conventional Mesialslider, which is just attached to the molars and the T-Mesialslider, the clinical use of additional **b**onded tubes (B-Mesialslider, Fig. 2) is described in this paper.

Clinical procedure using the B-Mesialslider

After topical or local anesthesia mini-implants (2 × 9 mm anterior and 2 × 7 mm posterior) are inserted median or paramedian in the anterior palate posterior to the third rugae (Fig. 3, T-Zone).[25] Pre-drilling is only needed if mini-implants are inserted median in adult

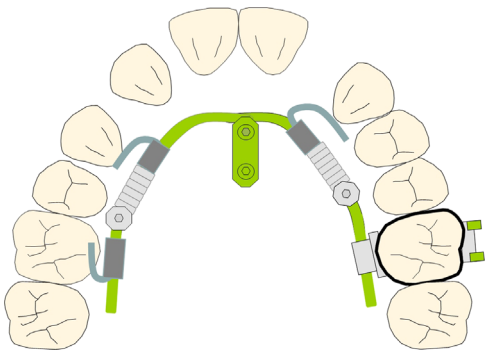

Figure 2. B-Mesialslider. Instead of bands sliding tubes can be bonded on the palatal surface of all upper teeth.

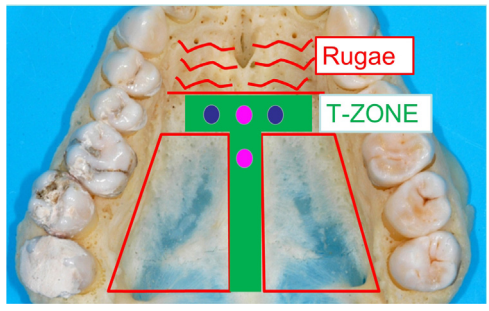

Figure 3. Recommended insertion sites within the T-zone. TADs can be inserted median or paramedian.

Figure 4. A Benefit mini-implant with an inner thread.

patients due to the cortical bone structure of the adult suture. Generally, the Benefit mini-implants are self-drilling and thus can be inserted without pre-drilling in children, adolescents and the paramedian area of adults. It is recommendable to use mini-implants with an inner thread and exchangeable abutments (e.g., Benefit System, PSM, Fig. 4) to achieve a stable and safe connection between the mini-implants and the mesialization mechanics. To increase the stability, two mini-implants are coupled by a plate (Beneplate, Fig. 5A)[17] with a 1.1 mm stainless steel wire in place. To fix the Beneplate on top of the mini-implants, two small fixing screws are used (Fig. 5B). For coupling with the molars, bands with palatal sheaths and tubes (Fig. 6A) can be used and fixed to the molars. Afterwards, the wire of the Beneplate is adapted to the curvature of the palate. This

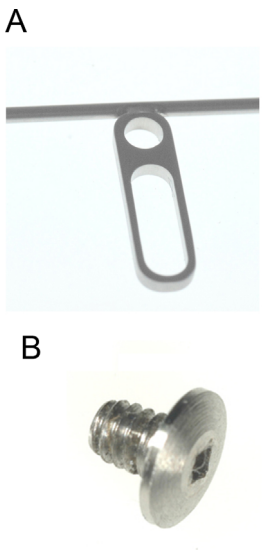

Figure 5. The Mesialslider comprises a Beneplate with a 1.1 mm stainless steel wire in place (A) that can be fixed on top of the mini-implants using small fixing screws (B).

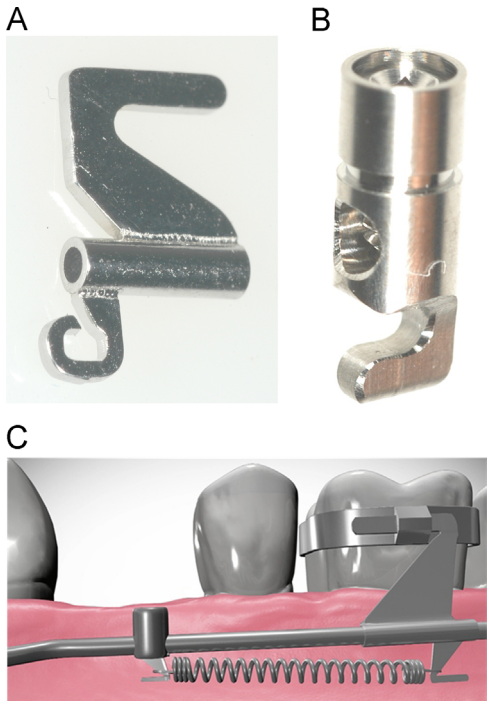

Figure 6. A tube (A) can be stuck into the sheaths of molar bands for connection with the Mesialslider. The closing spring is attached to the activation stop. Both tube and stop have small hooks in place for an easy application of the springs or elastic chains (C).

Figure 7. Tubes can be adapted and bonded for bodily movements of teeth without bands.

Figure 8. A 13-year old female patient with two missing upper lateral incisors.

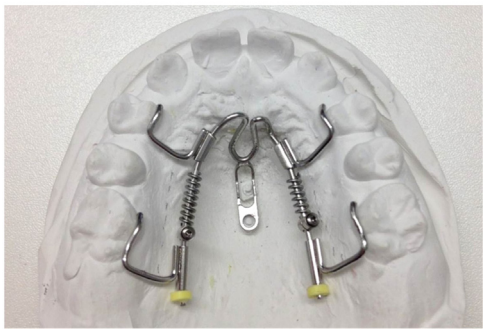

Figure 9. Two Benefit mini-implants were inserted in the palate and the Mesialslider appliance was bent on a plaster model.

adaption can be done chairside or after impression taking on a plaster model. The mesialization force is delivered by NiTi closing springs (200 g), that are attached to the activation locks (Fig. 6, conventional Mesialslider) or a NiTi open spring (240 g) if a B-Mesialslider is used (pull or push mechanics). The Beneplate is fixed by two fixing screws (5B)

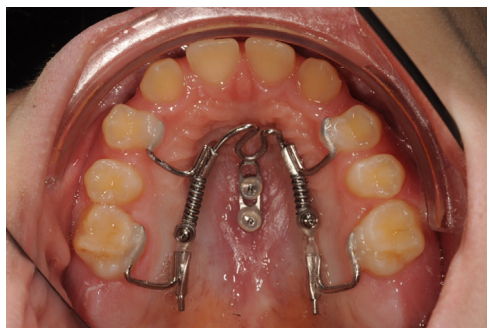

Figure 10. Mesialslider installed with 4 bonded tubes. Mesialization forces are applied using 2 NiTi springs (premolars) and two elastic chains (molars).

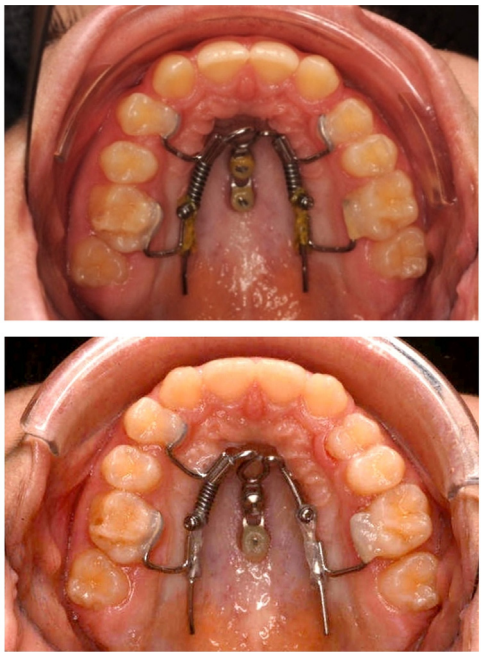

Figure 11. Progress of mesialization after 5 (upper picture) and 8 (lower picture) months.

using a contra-angle. Finally, the Mesialslider is activated by pushing the activation locks mesially (Fig. 6C). Follow up controls are scheduled every 4–6 weeks. In order to mesialize the canines or the 1st bicuspids bodily, bonded tubes (Fig. 7, according to Dr. Banach) can be used (Fig. 2, B-Mesialslider). As a consequence, brackets are generally not necessary during the whole mesialization period. Advantages are a more esthetic treatment and less friction. All different Mesialslider devices (conventional, T, and B) can be installed without laboratory work like welding or soldering. In other words, the Mesialslider can be adapted and bent directly in the oral cavity without impression taking. However, in order to save chair time, the mechanics can also be adapted on a plaster model. For this purpose, impression caps and laboratory analogues are employed.

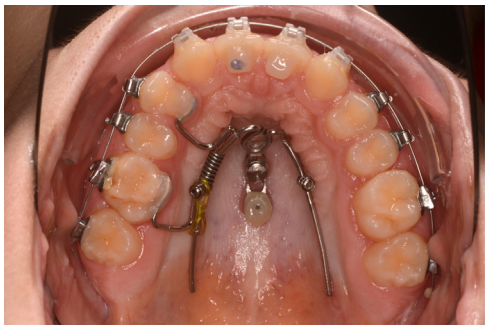

Figure 12. After 10 months spaces were closed and brackets were bonded.

Table. Cephalometric summary.

Area of study	*Norms ± SD*	*Pretreatment*	*Posttreatment*
Case 1			
Maxilla and mandible to cranial base			
SNA	82° ± 3°	87.7°	87.2°
SNB	80° ± 3°	87.4°	87.8°
Maxillo-mandibular relations			
ANB	2° ± 2°	0.3°	−0.6°
Wits	1 ± 2 mm	1.4 mm	0.4 mm
Vertical height			
NL-NSL	8.5°± 3°	0.6°	1.5°
NL-ML	23.5° ± 3°	19.7°	23.2°
Maxillary and mandibular incisor position			
U1-NL	112.5° ± 3°	103.1°	116.6°
L1-ML	90° ± 3°	80.2°	96.4°
U1-L1	131° ± 6°	109.4°	87.3°
Overjet	2 ± 1 mm	3.7 mm	2.8 mm
Overbite	2 ± 2 mm	4.5 mm	1.5 mm
Case 2			
Maxilla and mandible to cranial base			
SNA	82° ± 3°	85.0°	89.7°
SNB	80° ± 3°	82.6°	87.1°
Maxillo-mandibular relations			
ANB	2° ± 2°	2.3°	2.6°
Wits	1 ± 2 mm	−0.7 mm	1.8 mm
Vertical height			
NL-NSL	8.5° ± 3°	5.7°	2.6°
NL-ML	23.5° ± 3°	18.1°	16.3°
Maxillary and mandibular incisor position			
U1-NL	112.5° ± 3°	108.1°	120.0°
L1-ML	90° ± 3°	96.3°	98.3°
U1-L1	131° ± 6°	143.8°	87.3°
Overjet	2 ± 1 mm	2.5 mm	2.9 mm
Overbite	2 ± 2 mm	3.3 mm	1.4 mm

Case 1

The treatment protocol of a 13-year old female patient with two missing upper lateral incisors is shown (Fig. 8, Table). Two Benefit mini-implants were inserted in the anterior palate (Fig. 9) and a Mesialslider with Banach tubes (Fig. 7) was bent on a plaster model after impression (Fig. 9). Adaption was not performed chairside to save chair time, which meant a shorter and more comfortable appointment for the patient. There was no need for welding or soldering in the

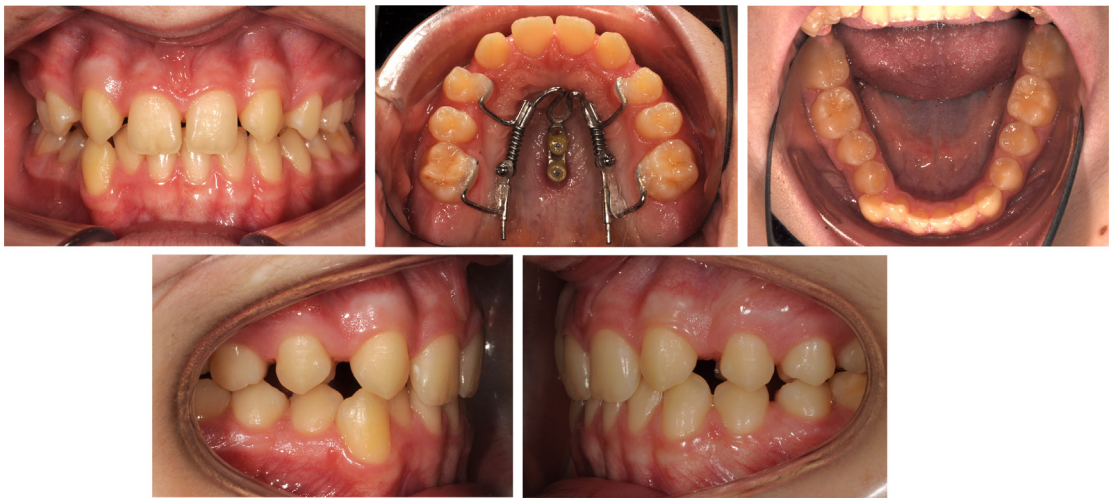

Figure 13. Intraoral situation after 1 month. The patient appreciated the invisibility of the treatment in the first 10 months.

construction of this appliance. After 1 week, the B-Mesialslider was attached to 1st bicuspids and 1st molars using light curing composite (Fig. 10). After 8 months spaces were almost closed to the mesial (Fig. 11), and after 10 months brackets were bonded (Fig. 12). The patient was very

Figure 14. Progress after 2 years of treatment and 14 months in braces.

Figure 15. The radiographs after 2 years show a bodily mesialization of the molars.

pleased during the first 10 months of her treatment due to the "invisible" treatment appliance without backets and any demands on compliance (Fig. 13). The treatment was in the finishing phase after 2 years, intraoral and radiologic findings both show a good bodily mesialization (Figs. 14 and 15). The patient was debonded after a total treatment time of 2 years and 6 months; an appropriate overjet and overbite were achieved (Figs. 16 and 17). The cephalometric superimposition is shows a significant upper molar protraction and bialveolar protrusion (Fig. 18). For

Figure 16. Situation after debonding. The total treatment time was 2 years and 6 months.

Figure 17. Orthopantomogram shows a good bodily mesialization. Upper wisdom teeth are in place and have a good chance to erupt.

the retention period, a removable retainer was used (Fig. 19).

Case 2

The treatment protocol of a 13-year old male patient with one missing upper left lateral incisor and one peg shaped right lateral is shown (Figs. 20 and 21). After a comprehensive patient discussion, mother and patient opted for extraction of the peg-shaped lateral incisor and a symmetrical space closure in both upper quadrants. The treatment started with insertion of two Benefit mini-implants in the palate (Fig. 22) and adaptation of two molar bands with sheaths. Afterwards, a Mesialslider with two Banach tubes for the first premolars was bent chairside (Fig. 23). The mesialization force applied to the bicuspids was delivered by two NiTi open springs. Additionally, elastic chains were connected to the molars. After 10 months spaces were almost closed to the mesial (Fig. 24), while after 2 more months spaces were closed and brackets were bonded (Fig. 25). Patient was very happy during the first 12 months of his treatment due to the invisible treatment with no need for compliance and no brackets (Fig. 26). After 2 years in active treatment, intraoral pictures and radiologic findings show a good bodily mesialization (Figs. 27 and 28). The patient was debonded after the finishing phase and a total treatment time of 2 years and 5 months (Figs. 29 and 30). The cephalometric superimposition demonstrates a significant upper molar protraction without anchorage loss of the incisors (Fig. 31). The result was quite stable after 1 year in retention (Fig. 32).

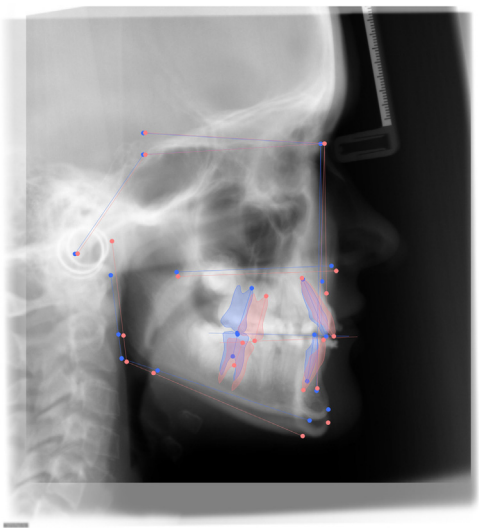

Figure 18. Superimposition of before and after cephalograms (Table).

Reshaping of the front teeth after space closure

After space closure to the mesial, canine substitutions can be accomplished with good aesthetic outcomes by tooth reshaping and positioning, bleaching and porcelain veneers.[6–8] However, many patients are very happy with their treatment result and refuse major reshaping, intrusion of first premolars and subsequent need for restorations. The patients and parents wished

Figure 19. Patient (case 1) 1 year in retention.

Figure 20. A 13-year old male patient with one missing upper left lateral incisor and one peg shaped right lateral incisor.

Figure 21. Radiographs of case 2.

no (case 1) or only minor (case 2) esthetic enhancements (canine reshaping). If a more sophisticated result is desired, first premolars can be intruded and canines extruded with the goal of a perfect margin contour. These vertical tooth movements of the canines and the first bicuspids may improve the esthetic outcome and are not causing any long-term periodontal or functional problems.[26]

Discussion

The two alternative treatment approaches for congenitally missing upper lateral incisors are space closure and space opening. Both of these treatment approaches have their pros and cons.[2] However, due to the high risk of long-term esthetic complications from infra-positioning of single-tooth dental implants, because of continuing growth and the eruption of adjacent teeth, space closure seems more reasonable in many cases. According to the guidelines of the Angle Society of Europe,[5] this has to be considered especially in patients with a major visibility of upper front teeth, e.g., in gummy smile situations. Canine substitutions can be accomplished with good aesthetic outcomes by tooth reshaping and positioning, bleaching and porcelain veneers (Figs. 33–36).[6–8] To facilitate upper space closure, mini-implants in the palate seem to be a very reasonable option to provide maximum anchorage. The anterior palate proved to be a suitable insertion site, where mini-implants with larger dimensions and a higher stability[27,28] can be placed in a region of high bone quality, thin overlying soft tissue and a nearly negligible risk of interference with teeth or potential root damage.[29] The bone volume is reduced in the lateral and posterior areas of the palate.[30,31] Hence, in the posterior area of the palate, only a median insertion is recommended. The area immediately distal to the third palatal rugae, referred to as the "T-Zone", remains the preferred region for the insertion of palatal

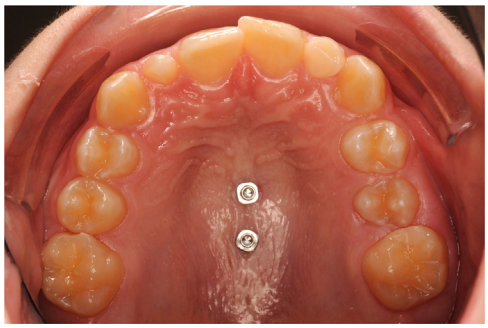

Figure 22. Benefit mini-implants inserted in the palate.

Figure 23. Mesialslider with two bonded tubes on the first premolars and two bands on the first molars. Mesialization force to the bicuspids was delivered by two NiTi springs and elastic chains connected to the molars.

Figure 24. Molar and premolar mesialization after 6 (left) and 10 (right) months.

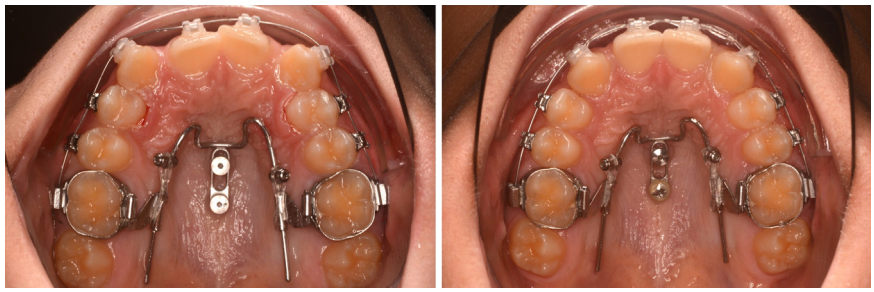

Figure 25. After 12 months spaces are almost closed and brackets are bonded (left), 2 months after beginning of levelling (right).

Figure 26. Intraoral situation after 6 months of using the "invisible" Mesialslider.

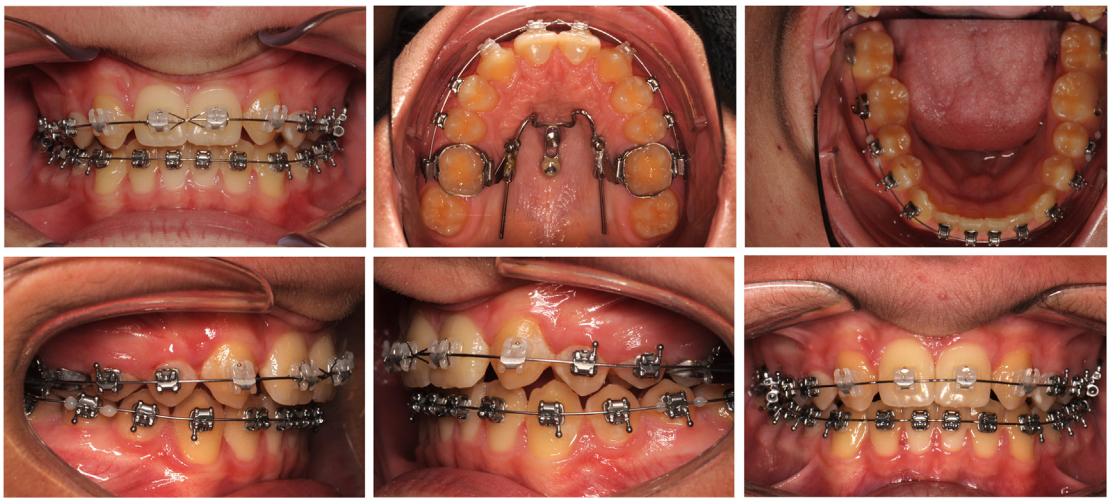

Figure 27. Intraoral pictures during the finishing phase after 2 years in active treatment.

mini-implants (Fig. 3). The positioning of the two adjacently located mini-implants can be performed in a sagittal (median insertion, case 1 and 2) or transversal (paramedian insertion, case 3) direction.[17] Advantages of paramedian insertion are the distance to the incisive canals and the suture, whilst advantages of a median insertion are more readily available quantity of bone and reduced risk of incisor tooth root injury during insertion.[25]

The Mesialslider proved to be a reliable appliance for non-compliance upper space closure. Especially the B-Mesialslider has some major advantages compared to other anchorage mechanisms for upper space closure:

— No need for compliance (e.g., class III elastics),
— Since the incisors are not fixed, a midline deviation can be corrected and/or incisors can be protruded ("reverse anchorage loss" phenomenon),[20]
— Brackets are not needed for the mesialization period, which shortens the time in fixed braces significantly,
— Combination with aligners is possible and very reasonable. Thus the spectrum of aligners is broadened significantly following this strategy: non-compliance space closure (difficult tasks/bodily movements) with the Mesialslider, afterwards finishing with aligners (easy tasks).

Figure 28. Radiologic findings after 1 year in active treatment, a good bodily mesialization is visible.

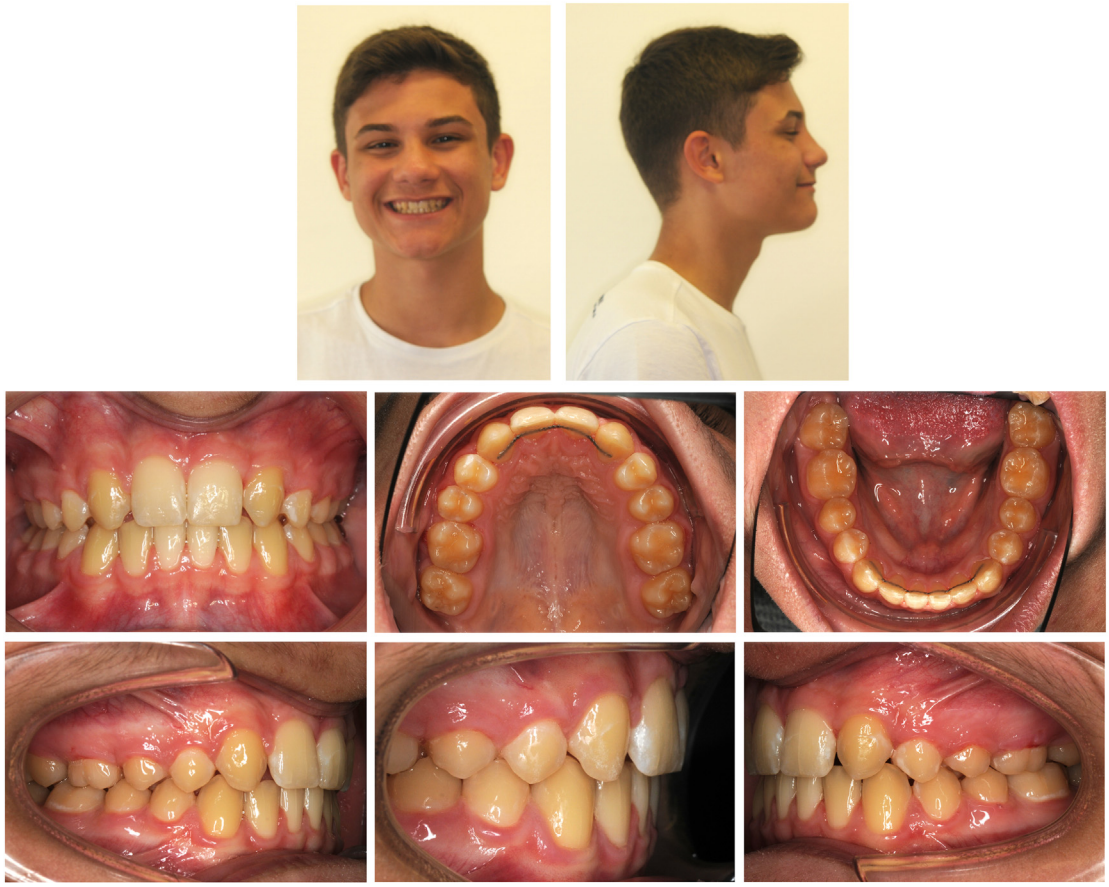

Figure 29. The patient was debonded after a total treatment time of 2 years and 5 months.

Figure 30. Orthopantomogram of case 2 at the treatment end.

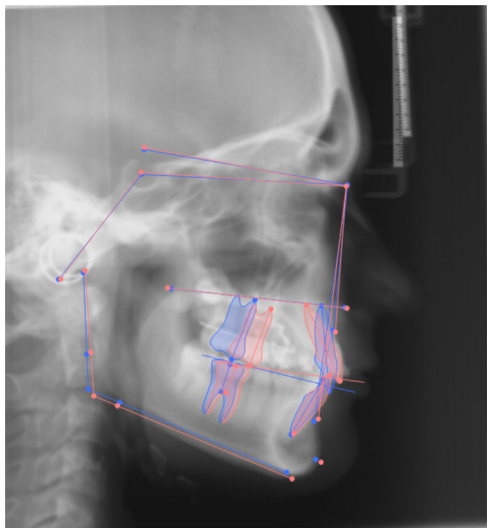

Figure 31. Superimposition of before and after (Table).

Figure 32. Patient in retention phase 1 year after debonding. Upper canines have been reshaped using composite.

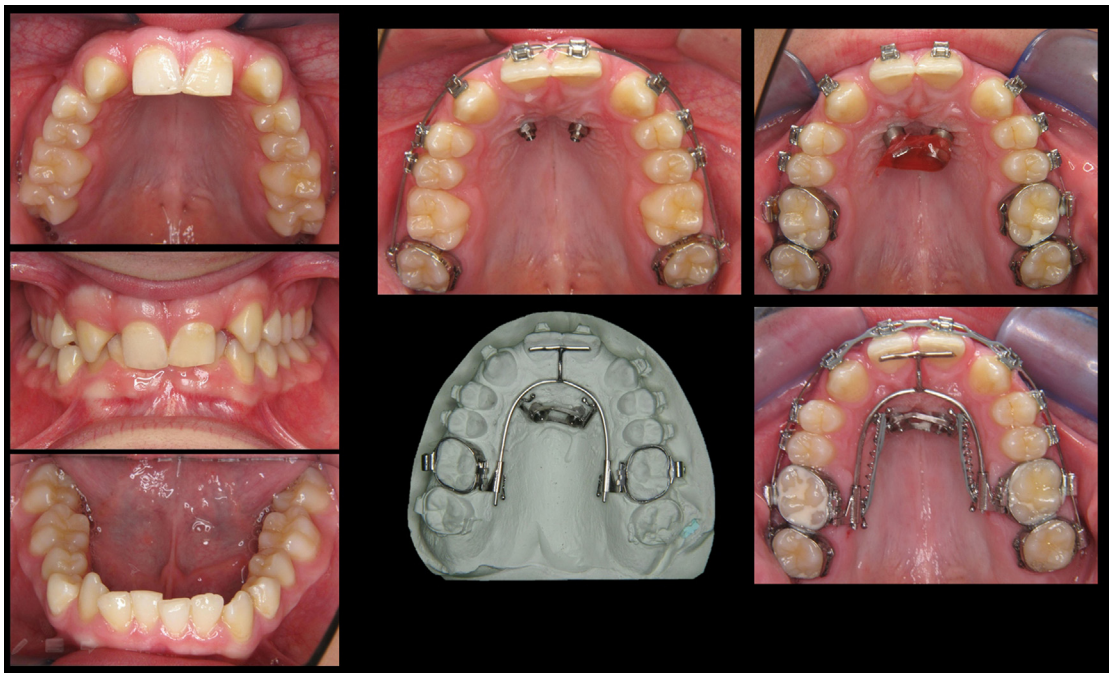

Figure 33. Patient with missing laterals. Upper space closure was achieved using the T-Mesialslider and paramedian Benefit mini-implants.

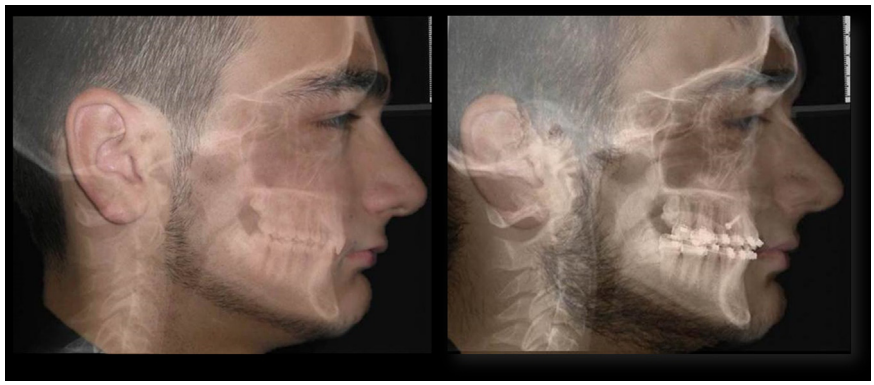

Figure 34. "Reverse anchorage phenomenon": spaces are closed to the mesial and upper front was protruded due to friction.

Figure 35. Situation after space closure during the finishing period.

Figure 36. Perfect esthetic reshaping of all upper front teeth using 6 veneers.

Conclusions

The Mesialslider is a reliable mesialization device for the upper dentition. Since it is borne on palatally inserted mini-implants, mesial movement of the teeth will not interfere with the TADs. Usage of pre-fabricated components facilitates installation of the appliance without the need for an impression/laboratory procedure. If the B-Mesialslider with bonded tubes at the 1st premolars/canines is used, brackets are not needed for the mesialization period. As a consequence, the time in fixed braces can be significantly reduced or even eliminated.

References

1. Altug-Atac AT, Erdem D. Prevalence and distribution of dental anomalies in orthodontic patients. *Am J Orthod Dentofacial Orthop.* 2007;131:510–514.
2. Robertsson S, Mohlin B. The congenitally missing upper lateral incisor. A retrospective study of orthodontic space closure versus restorative treatment. *Eur J Orthod.* 2000;22:697–710.
3. Zitzmann NU, Arnold D, Ball J, Brusco D, Triaca A, Verna C. Treatment strategies for infraoccluded dental implants. *J Prosthet Dent.* 2015;113:169–174.
4. Oesterle LJ, Cronin RJ Jr., Ranly DM. Maxillary implants and the growing patient. *Int J Oral Maxillofac Implants.* 1993;8:377–387.
5. Johal A, Katsaros C, Kuijpers-Jagtman AM. Angle Society of Europe m. State of the science on controversial topics: missing maxillary lateral incisors—a report of the Angle Society of Europe 2012 meeting. *Prog Orthod.* 2013;14:20.
6. Zachrisson BU, Rosa M, Toreskog S. Congenitally missing maxillary lateral incisors: canine substitution. Point. *Am J Orthod Dentofacial Orthop.* 2011;139434, 436, 438 passim.
7. Rosa M, Zachrisson BU. The space-closure alternative for missing maxillary lateral incisors: an update. *J Clin Orthod.* 2010;44:540–549quiz 561.
8. Rosa M, Zachrisson BU. Integrating space closure and esthetic dentistry in patients with missing maxillary lateral incisors. *J Clin Orthod.* 2007;41:563–573quiz 424.
9. Fritz U, Diedrich P, Kinzinger G, Al-Said M. The anchorage quality of mini-implants towards translatory and extrusive forces. *J Orofac Orthop.* 2003;64:293–304.
10. Costa A, Raffainl M, Melsen B. Miniscrews as orthodontic anchorage: a preliminary report. *Int J Adult Orthodon Orthognath Surg.* 1998;13:201–209.
11. Wilmes B, Fields of application of mini-implants. In: Ludwig B, Baumgaertel S, Bowman J, eds. *Innovative Anchorage Concepts. Mini-Implants in Orthodontics.* Berlin, NY: Quintessenz; 2008.
12. Wilmes B, Olthoff G, Drescher D. Comparison of skeletal and conventional anchorage methods in conjunction with pre-operative decompensation of a skeletal class III malocclusion. *J Orofac Orthop.* 2009;70:297–305.
13. Ludwig B, Glasl B, Bowman SJ, Wilmes B, Kinzinger GS, Lisson JA. Anatomical guidelines for miniscrew insertion: palatal sites. *J Clin Orthod.* 2011;45:433–441.
14. Hourfar J, Bister D, Kanavakis G, Lisson JA, Ludwig B. Influence of interradicular and palatal placement of orthodontic mini-implants on the success (survival) rate. *Head Face Med.* 2017;13:14.
15. Lim HJ, Choi YJ, Evans CA, Hwang HS. Predictors of initial stability of orthodontic miniscrew implants. *Eur J Orthod.* 2011;33:528–532.
16. Karagkiolidou A, Ludwig B, Pazera P, Gkantidis N, Pandis N, Katsaros C. Survival of palatal miniscrews used for orthodontic appliance anchorage: a retrospective cohort study. *Am J Orthod Dentofacial Orthop.* 2013;143:767–772.
17. Wilmes B, Drescher D, Nienkemper M. A miniplate system for improved stability of skeletal anchorage. *J Clin Orthod.* 2009;43:494–501.

18. Wilmes B, Drescher D. A miniscrew system with interchangeable abutments. *J Clin Orthod*. 2008;42:574–580 [quiz 595].
19. Baumgaertel S. Maxillary molar movement with a new treatment auxiliary and palatal miniscrew anchorage. *J Clin Orthod*. 2008;42:587–589[quiz 596].
20. Wilmes B, Nienkemper M, Nanda R, Lubberink G, Drescher D. Palatally anchored maxillary molar mesialization using the mesialslider. *J Clin Orthod*. 2013;47:172–179.
21. Wilmes B, Katyal V, Willmann J, Stocker B, Drescher D. Mini-implant-anchored Mesialslider for simultaneous mesialisation and intrusion of upper molars in an anterior open bite case: a three-year follow-up. *Aust Orthod J*. 2015;31:87–97.
22. Wilmes B, Drescher D. Application and effectiveness of the Beneslider: a device to move molars distally. *World J Orthod*. 2010;11:331–340.
23. Wilmes B, Nanda R, Nienkemper M, Ludwig B, Drescher D. Correction of upper-arch asymmetries using the Mesial-Distalslider. *J Clin Orthod*. 2013;47:648–655.
24. Ludwig B, Zachrisson BU, Rosa M. Non-compliance space closure in patients with missing lateral incisors. *J Clin Orthod*. 2013;47:180–187.
25. Wilmes B, Ludwig B, Vasudavan S, Nienkemper M, Drescher D. The T-Zone: median vs. paramedian insertion of palatal mini-implants. *J Clin Orthod*. 2016;50:543–551.
26. Rosa M, Lucchi P, Ferrari S, Zachrisson BU, Caprioglio A. Congenitally missing maxillary lateral incisors: long-term periodontal and functional evaluation after orthodontic space closure with first premolar intrusion and canine extrusion. *Am J Orthod Dentofacial Orthop*. 2016;149:339–348.
27. Wilmes B, Ottenstreuer S, Su YY, Drescher D. Impact of implant design on primary stability of orthodontic mini-implants. *J Orofac Orthop*. 2008;69:42–50.
28. Wilmes B, Drescher D. Impact of bone quality, implant type, and implantation site preparation on insertion torques of mini-implants used for orthodontic anchorage. *Int J Oral Maxillofac Surg*. 2011;40:697–703.
29. Ludwig B, Glasl B, Bowman SJ, Wilmes B, Kinzinger GS, Lisson JA. Anatomical guidelines for miniscrew insertion: palatal sites. *J Clin Orthod*. 2011;45:433–441[quiz 467].
30. Kang S, Lee SJ, Ahn SJ, Heo MS, Kim TW. Bone thickness of the palate for orthodontic mini-implant anchorage in adults. *Am J Orthod Dentofacial Orthop*. 2007;131:S74–S81.
31. Hourfar J, Kanavakis G, Bister D, Schatzle M, Awad L, Nienkemper M, et al. Three dimensional anatomical exploration of the anterior hard palate at the level of the third ruga for the placement of mini-implants—a cone-beam CT study. *Eur J Orthod*. 2015;37:589–595.