

Orthodontic treatment with removal of one mandibular incisor: Outcome data and the importance of extraction site preparation

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Introduction: Extraction of one mandibular incisor in adolescents and adults can simplify orthodontic treatment in 2 major circumstances: (1) severe crowding of the mandibular but not the maxillary incisors, and (2) mild anterior crossbite with good alignment in both arches. Despite its potential advantages, this method has had limited use in most practices. There have been 3 major objections: (1) the possibility of unsightly black triangles because of loss of interdental papilla height, (2) a possible tooth size discrepancy that would affect occlusal relationships, and (3) patient concerns about a visible extraction site. All 3 objections now can be overcome. **Methods:** For 37 consecutively treated single-incisor-extraction patients, preparation of the extraction site for the tooth to be extracted was done by tipping it lingually while simultaneously closing the space in front of it. Treatment outcomes and the effect of age at the time of treatment were evaluated. **Results:** In patients below age 20, this approach eliminated post-treatment black triangles and almost eliminated partial loss of the interdental papilla. It reduced the previously reported prevalence of these problems in patients aged 20-40 years and did not seem to be helpful in those aged over 40 years. This positive effect was achieved because of maintenance of alveolar crest height that supports the interdental papillae. Tooth size discrepancy caused by incisor extraction was largely compensated by the different labio-lingual orientation of maxillary and mandibular anterior teeth. The extraction space quickly disappeared during extraction site preparation. **Conclusions:** The new procedure of extraction site preparation described in this paper offers more favorable outcomes for post-treatment prevalence of black triangles in younger patients but shows limited efficacy in older patients. Camouflage of a mild skeletal Class III problem is the major indication for this extraction pattern. About 3% of Icelandic orthodontic patients appear to be good candidates for this treatment, and this finding should be reasonably generalizable to other populations of European descent. (*Am J Orthod Dentofacial Orthop* 2019;156:453-63)

In specific types of cases, removal of one mandibular incisor can greatly facilitate orthodontic treatment. There are 2 primary indications: (1) severe crowding in the mandibular arch but minimal crowding in the maxillary arch, and (2) mild anterior crossbite but good alignment in a patient with a skeletal Class III tendency.

In a sense, these 2 different malocclusion patterns are variants of the same problem, a lack of dental compensation for a mild to moderate Class III malocclusion jaw relationship. In a more severe skeletal Class III problem that requires orthognathic surgery, one mandibular incisor extraction may be still be preferred to deal with crowding in the mandibular but not the maxillary arch. A third indication is a discrepancy in the anterior arch form, with a U-shaped mandibular dental arch and a V-shaped maxillary arch.

For these patients, the alternative in most instances is to remove mandibular second premolars. This approach means, however, that even if there is no crowding in the maxillary arch, one still needs to remove second premolars in the maxillary arch, or perhaps remove maxillary second molars, because those teeth will not have an antagonist after the premolar extraction in the

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mandibular arch; thus the patient loses 4 teeth to solve the orthodontic problem instead of only 1. The other negative aspects of premolar extraction in cases for which one mandibular incisor extraction could be used are that the anterior teeth in both arches might also be moved lingually with an undesirable reduction in lip support, and that the orthodontic treatment time is likely to be lengthened substantially. It is generally conceded that satisfactory dental occlusion can be achieved with extraction of one mandibular incisor in selected cases. That was one of the conclusions of a systematic review of the literature that was published in 2011.¹ Ileri et al² reported in 2012 that outcomes were similar in patients with crowded teeth who were treated with arch expansion, premolar extraction, and mandibular incisor extraction; and a recent report from Aga Khan University in Karachi showed the same improvement in peer assessment rating scores in mandibular incisor extraction patients as with premolar extraction and arch expansion.³ In their report in 1999 on long-term recall of 36 patients who had extraction of one mandibular incisor, Faerovig and Zachrisson⁴ reported no periodontal health problems and only a small number of reduced or missing papillae.

Most orthodontists probably know that removing 1 mandibular incisor instead of 2 or 4 premolars in patients who could be treated either way simplifies the orthodontic treatment and tends to shorten treatment time. Why do they rarely do that? One concern is a resultant tooth size discrepancy—but when the maxillary incisors are proclined and the mandibular incisors are upright, the typical outcome in patients selected for removal of 1 mandibular incisor, often a functional occlusion in the anterior and posterior quadrants is obtained with little or no interproximal reduction of incisors. It is important to remember that the classic ratios for tooth size discrepancy apply only to situations in which the inclination of the incisors is not compensated in this way.⁵⁻⁷

In the senior author's practice in Iceland, some patients have rejected the suggestion of extraction of 1 mandibular incisor because of concern about having an unsightly visible extraction space during treatment. A more pressing esthetic concern is the possibility of gingival recession that leads to a black triangle because of the loss of the interdental papilla between the teeth at the extraction site (Fig 1). This occurs when the underlying crestal bone remodels during the space closure and the height of the interdental bone crest decreases.

Reviewing the outcomes in 51 patients with 1 mandibular incisor extraction who were treated either at the University of Connecticut or in 6 private practices in that state, Uribe et al⁸ discussed this problem in detail and showed clinical pictures of black triangles that appeared after mandibular incisor removal. They reported



Fig 1. A visible black triangle after extraction of a mandibular right lateral incisor for orthodontic treatment of a 48-year-old woman. As the lips descend with aging, this is more likely to be noticeable.

that 62% of the female patients and 77% of the males had an open gingival embrasure after treatment. For the combined genders, 22% of these open embrasures were rated as very noticeable and 14% as moderately noticeable, and they noted that the risk of an open embrasure was slightly greater with extraction of a central than a lateral incisor. They “painted the situation black” and did not suggest a solution to this problem. After reading their paper and seeing the photos, one would think twice about selecting this treatment option. Pithon et al⁹ also concluded that that black triangles affected the esthetics of mandibular incisor extraction treatment and recommended avoiding this approach.

There is a solution to both the visible empty space and black triangle problems, however, that is not widely recognized: a technique developed by the senior author that is best described as extraction site preparation. It decreases the effect on the crestal bone and thereby decreases the number and size of black triangles. The purpose of this paper is to describe it and offer data both for its effectiveness and treatment time.

MATERIAL AND METHODS

Extraction site preparation is done in 2 steps: first, orthodontically tipping the incisor that is to be removed lingually to a safer location for its removal, and then closing most of the space in front of it before it is extracted. This moves the new extraction site away from the delicate crestal bone and usually preserves the height of the alveolar crest where the tooth used to be. It also addresses the possible patient concern about the esthetic effect of removing an anterior tooth. With this approach, the tooth is moved out of the way quickly, and one day, it disappears without anyone noticing.

It is quite easy to tip a mandibular incisor lingually. For closure of a single mandibular incisor space, an

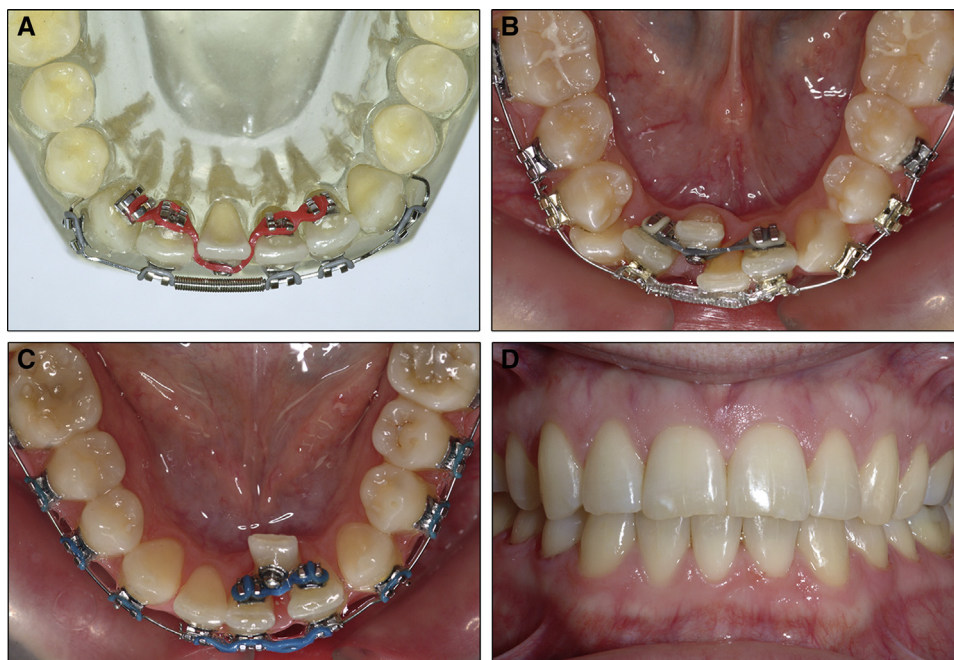


Fig 2. Preparation of a mandibular incisor extraction site. **A**, The mechanism for lingual tipping of the selected incisor shown on a typodont. An elastomeric chain from lingual brackets adjacent to the tooth to be extracted passes across its labial surface. A low-profile button bonded on the labial maintains the chain's vertical position. Initially, a nearly passive coil spring on a labial wire segment prevents heavy pressure on the contact points, which would impede the desired lingual tipping, especially if the contact points are flat. **B**, Once the selected incisor has broken away from its contact points, the coil spring is removed, and then the chain both tips the tooth lingually and begins space closure in front of it. **C**, The patient is ready for extraction of the incisor when it is tipped to approximately a 45° angle lingually and the adjacent teeth are nearly in contact in front of it. At that point the incisor has all but disappeared behind the adjacent teeth. **D**, For this patient (**C** and **D**) successful treatment including extraction of the mandibular left central incisor resulted in no visible soft tissue changes or loss of alveolar bone crest height.

elastomeric chain is the most practical method (Fig 2). As soon as the selected tooth begins to tip lingually, the 2 neighboring teeth start to tilt toward each other and then the consolidating force of the elastomeric chain continues to close the space. This lingual movement of the incisor before it is extracted helps to conserve the crestal bone in the area. At the completion of treatment, especially in adolescents and young adults, one would expect no loss of alveolar crest height or visible soft tissue changes (see outcome data below).

The decision to remove a mandibular incisor does need careful consideration. It is very helpful to do a model setup by rearranging the mandibular anterior teeth after removal of 1 incisor and observing the resulting incisor and posterior occlusal relationships (Fig 3). As we have noted, proclination of the maxillary incisors and upright mandibular incisors compensates to a major extent for what would be a tooth size discrepancy with standard incisor inclinations. Removal of a mandibular

incisor places the mandibular canines in a more mesial relationship to the maxillary arch, so it is advantageous if the maxillary laterals are small mesio-distally, because then the maxillary canines will also be more to the mesial (Fig 4). A narrow and somewhat V-shaped maxillary arch also fits well with 1 mandibular incisor extraction, because the incisor extraction constricts the width of the mandibular arch in the canine area. If the height of crestal bone at the extraction site is maintained, intact gingival papillae at the extraction site also are likely to be maintained (Fig 5).

Selecting the incisor to be removed can sometimes be difficult. One would want to remove a tooth that has enamel decalcification or has been shortened by attrition. But a main factor in preventing black triangles is to select for extraction the incisor with the greatest bone height around its cervical neck. If the height of the crestal bone is about the same around all the incisors, then it is usually easiest to select an incisor that is already

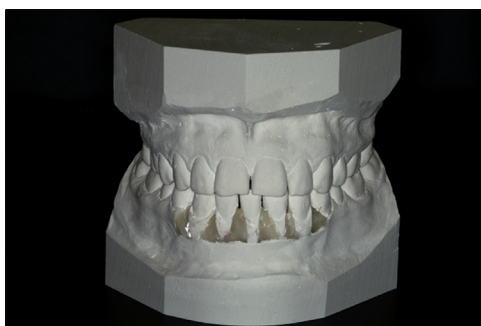


Fig 3. As this model setup shows, often the teeth fit together quite well after removal of 1 mandibular incisor. This occurs primarily because the mandibular incisors are upright, and the maxillary incisors are proclined in the pretreatment occlusal relationship, which compensates for the potential tooth size discrepancy. Model setups are critical in planning these cases to visualize whether the post-treatment incisor relationships and posterior occlusion would be acceptable.

lingually inclined. This is likely to be the same tooth with the best bone around it—and if so, that makes the selection easy. If the crowding is worse on one side, then it is sensible to select a tooth where the crowding is worst.

Selecting an incisor that is labially inclined and in the front of the other incisors usually is not a good decision. These teeth often have the worst bone height and it is difficult to move them lingually out of the arch. If such a tooth is the best one to extract for other reasons, site preparation still is possible by having a dental colleague do a root canal procedure on it; then it can be slenderized with a flame-shaped bur before moving it lingually in the usual way.

Although there is variation in the size of mandibular as well as maxillary lateral incisors, mandibular laterals are usually a little wider mesio-distally than centrals.¹⁰ If more space is needed, then a lateral is the tooth to select. But it is easier to remove a central incisor, because it is more difficult to upright the canine relative to a central than to a lateral incisor. In the previously noted Connecticut study, Uribe et al reported a larger chance of a black triangle if a central incisor was selected. That has not been the experience with extraction site preparation (see below).

Statistical analysis

Descriptive statistics were generated using SPSS (version 25.0; IBM SPSS, Armonk, NY). Demographic data calculated included both the gender and age of the patients in the sample. To evaluate the prevalence of unfilled embrasures, the frequency of affected patients was stratified by age. The frequency of the incisor



Fig 4. This patient's maxillary canines have a mesial position in the arch because of undersized maxillary lateral incisors. This also compensates for the potential tooth size discrepancy after mandibular incisor extraction. During treatment, the subsequent mesial movement of mandibular canines facilitated proper canine relations.

extracted, as well as the time to extraction (in months) were also calculated.

RESULTS

In the 15-year period between 2002 and 2017, the senior author treated 37 patients with extraction of 1 mandibular incisor after preparation of the extraction site as described above. Every patient during this time with this treatment approach was included in the sample. With consecutive numbering of the patients and no lost charts, it was possible to be sure that none of this group had been overlooked.

Demographic and timing data are shown in Table 1. All the patients were Icelandic natives, and two-thirds of them were female. Note that two-thirds of them were below age 20, 9 (24%) were between ages 20 and 40, and only 3 (8%) were over age 40. A central incisor was extracted in two-thirds of the patients, and the right central was twice as likely to be extracted as the left central. In the one-third who had a lateral incisor extracted, that ratio was reversed: the left one was more frequently selected.

The date at which treatment started and the date of extraction of the selected tooth were known precisely. The time between those dates, which is shown in Table 1, consists of the time for site preparation plus any delay after referral for the extraction. A safe conclusion is that almost all these patients would need <6 months for extraction site preparation.

We differentiated partially filled embrasures from completely unfilled ones. As Table II shows, there was an age influence on both. For the 25 patients under age 20, there were 3 partially filled embrasures that would not be noticeable, and no completely unfilled

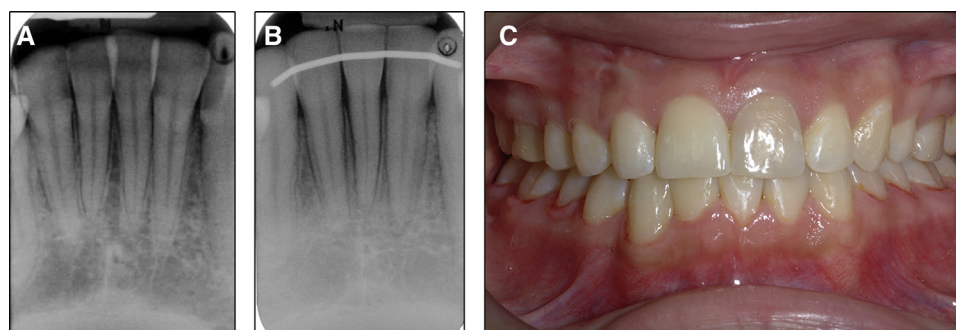


Fig 5. **A**, pretreatment periapical showing healthy crestal bone levels around the mandibular right central incisor, which is to be extracted. **B**, A post-treatment periapical radiograph of the same patient shows no loss of crestal bone height at the extraction site between the mandibular left central and right lateral incisors. Preservation of the crestal bone height is the key to avoiding loss of papilla height and a black triangle. **C**, Post-treatment view showing no loss of the dental papilla after extraction site preparation and comprehensive orthodontic treatment.

Table I. Demographic and timing data on mandibular incisor extraction in 37 consecutive patients, 2002–2017

Variable	Measure	n	%
Patients	Total	37	
	Female	25	68%
Age at start of treatment	Age <20 years	25	68%
	Age 20–40 years	9	24%
	Age >40 years	3	8%
Tooth extracted	Left central	8	22%
	Right central	16	43%
	Left lateral	8	22%
	Right lateral	5	13%
Time to extraction	2–3 months	18	49%
	4–6 months	15	40%
	>6 months	4	11%

embrasures (black triangles) that might be noticeable. For the 9 patients between 20 and 40, the percentage of affected embrasures was higher: 3 of the 9 patients had a partially filled embrasure and one had a completely unfilled embrasure. All 3 of the patients over age 40 had a completely unfilled embrasure.

Because all patients were consecutively numbered, this experience allows calculation of the percentage of patients in this practice who had 1 incisor extraction: 37 in 1336 total patients, or almost exactly 3%.

Two cases have been chosen to present adaptation to specific circumstances that always are necessary in using any treatment methodology.

Case 1. When you look at the initial photos of this patient at age 32 (Fig 6), you might think there is not much

Table II. Prevalence of unfilled embrasures (black triangles)

Magnitude of Embrasure	Age range	Group size	Affected	
			n	%
Partial	Age <20	25	3	12%
	Age 20–40	9	4	44%
	Age >40	3	0	0%
Complete	Age <20	25	0	0%
	Age 20–40	9	1	11%
	Age >40	3	3	100%

wrong here. She had previous orthodontic treatment elsewhere at approximately 10 years, 11 months in which the maxillary second premolars were removed because of crowding. No orthodontic treatment was done in the mandibular arch at that time. When she sought treatment 20 years later, she had reasonable alignment in both arches but zero overjet and overbite. Her main complaint was that she was grinding the incisal edges off her maxillary central incisors.

After a model setup, it was decided the best option was to remove the mandibular left central incisor so that the mandibular incisors could be moved backward into a more constricted arch form with correct overjet and overbite. Fixed appliances were placed in both arches, extraction site preparation was completed in <5 months, and the incisor was extracted at 5 months from the start of treatment. Class II elastics were used for 9 months to counteract too much uprighting of the mandibular incisor segment. The cephalometric superimposition shows that, as planned, the mandibular incisors were retracted and intruded about 2 mm, which allowed 2-mm elongation of the maxillary incisors to



Fig 6. Case 1, initial photos at age 32. Maxillary second premolars had been extracted for previous orthodontic treatment during adolescence that was limited to the maxillary arch. Minimal overjet and subsequent attrition of the maxillary incisors were concerns of the patient.

provide greater incisor display (Fig 7, A). At the completion of treatment at age 34 years, 6 months, there was no loss of bone at the extraction height (Fig 7, B). She had good tooth alignment, with no loss of papilla height at the extraction site and normal overjet and overbite, so that the dental attrition would not continue. She also had significantly improved dentofacial esthetics, primarily because of the improved maxillary incisor display (Fig 8). Bonded retainers were placed in both arches from canine to canine and were still in place at 4-year recall, with excellent stability.

Case 2. When this patient was seen initially at 7 years, 7 months, she had a severely constricted and retrognathic maxillary arch, a maxillary central diastema, and a somewhat prognathic mandible with the chin deviated slightly to the right. At that time the Wits relationship was -5 . She was placed on a bonded Hyrax expander and reverse-pull headgear, but it was necessary to remove maxillary first premolars to relieve the crowding in the maxillary arch. Because of the possibility of continued excessive mandibular growth, it was discussed with the parents that surgery probably would be necessary to complete the correction of the bite relationship at the completion of growth.

The reverse-pull headgear was continued until 9 years, 7 months. At age 14 we placed a Hyrax expander to increase the transverse width between the canines to

make it compatible with the planned surgery. At 15 years, 5 months, a wrist film radiograph showed that all bones of the hand had closed growth lines except the radius, but the ulna was closed. Based on that, completion of growth would be expected within the next 12 months.

On clinical examination at that time, her facial relationships (Fig 9) had improved somewhat, and a cephalometric radiograph showed that Wits was now -2 to -3 mm. She still had a mild mandibular asymmetry, with the midline of the chin about 3 mm to the left of the midline of the upper and midface, which is rarely noticed and was not a problem to the patient or parents—but to obtain ideal position of the jaws would require 2-jaw surgery despite the relatively mild malocclusion.

After discussion with parents and patient, it was decided to correct the bite relationship by extraction of the mandibular right central incisor. This would allow some retraction of the mandibular incisors so that the maxillary spacing could be corrected without creating an anterior crossbite. After space closure in the maxillary arch, a model setup showed that removing 1 central incisor should result in good occlusion. Extraction site preparation before the mandibular right central incisor was extracted took 4 months. Ten months later, incisor root paralleling was completed, but it became necessary to gain more room in the mandibular arch so that the

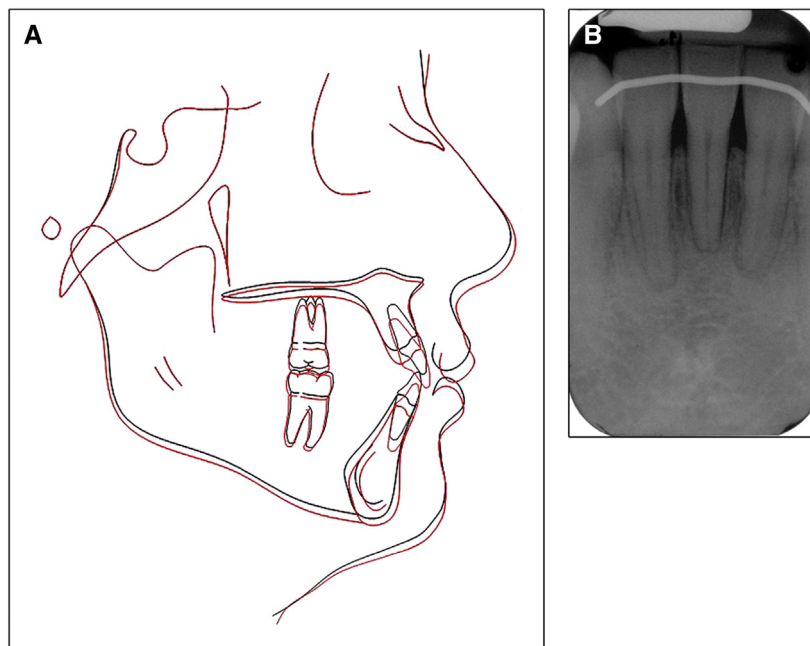


Fig 7. Case 1, continued. **A**, Superimposition of pre- and post-treatment cephalometric radiographs show retraction and intrusion of the mandibular incisors, which allowed elongation of the maxillary incisors. **B**, Crestal bone levels remained constant throughout treatment, maintaining full interdental papilla between the mandibular right central and mandibular left lateral incisors (Fig 8, E).

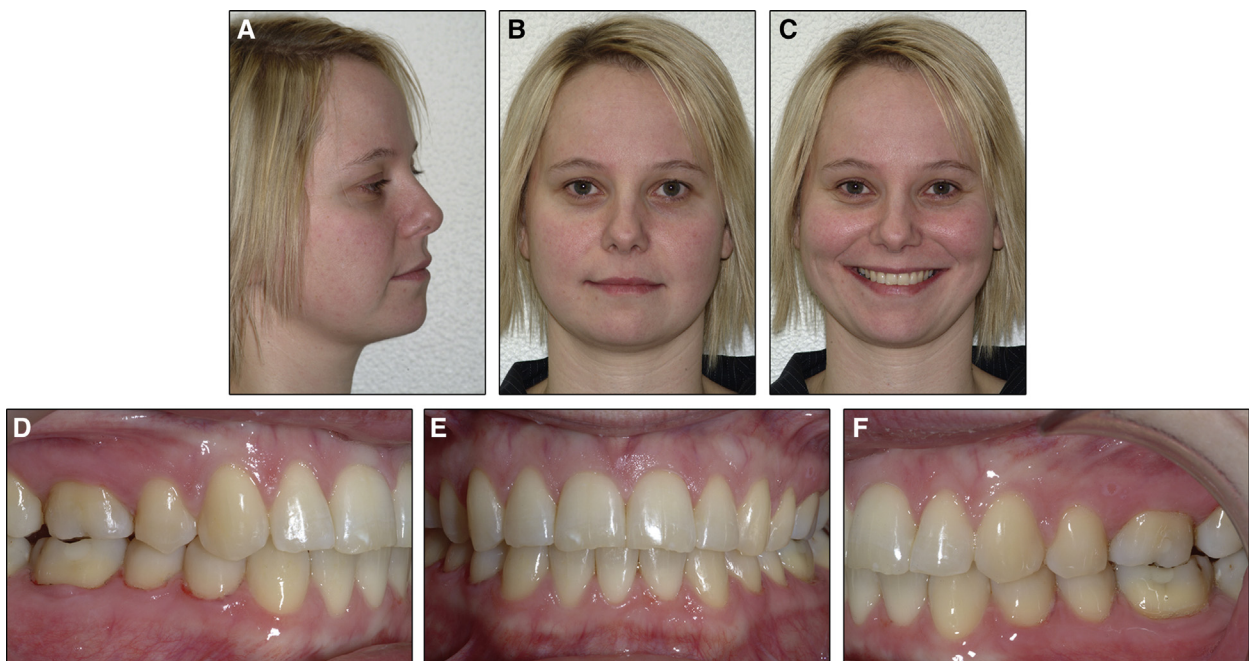


Fig 8. Case 1, continued. Patient at completion of treatment. **A-C**, Note the improved dentofacial esthetics with increased maxillary incisor display. **D-F**, Extraction of the mandibular left central incisor after extraction site preparation allowed normal overbite and overjet with no loss of interdental papilla height (which is more likely at her age of 32 but still occurs in only a minority of patients).

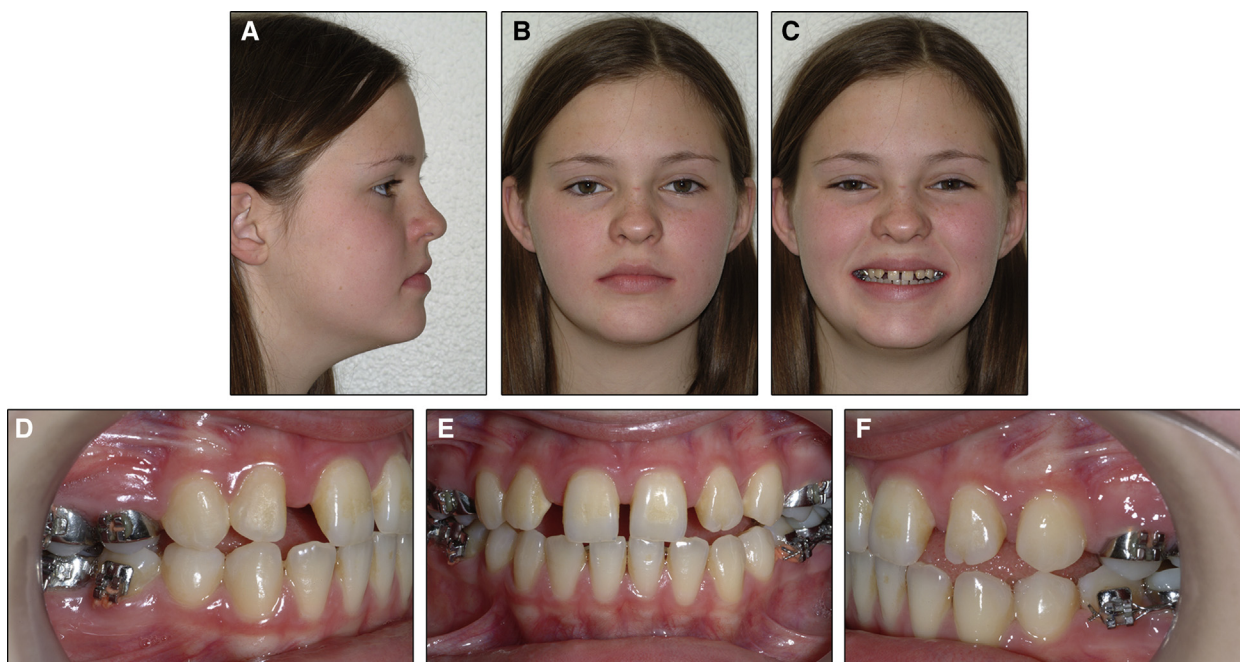


Fig 9. Case 2, initial photos at age 15-10. **A-C**, During phase 1 treatment, facial relationships had been improved by reverse-pull head gear, maxillary first premolars had been removed to relieve crowding, and transverse maxillary expansion had corrected a posterior crossbite. There was a moderate mandibular asymmetry, which could be corrected only by surgery. **D-F**, Intra-oral views show end-to-end incisor occlusion and spacing of the maxillary incisors, without enough overjet to align them without creating reverse overjet. The orthodontic option would be acceptance of the mandibular asymmetry and either extraction of both mandibular second premolars, with Class III elastics to help close the maxillary spacing. When surgery was ruled out, mandibular incisor extraction was chosen to limit distal movement of both the maxillary and mandibular incisor segments during space closure.

mandibular incisors could be retroclined further. Some interproximal enamel reduction was performed with a high-speed flame-shaped bur, and Class III elastics were worn for 6 months. Cephalometric superimposition showed almost no change in jaw relationships during treatment, with small retraction of the maxillary incisors as the diastema was closed, and about 4 mm mandibular incisor retraction (Fig 10, A).

After this treatment, there was no loss of alveolar bone height or papilla height (Fig 10, B). She had a functional though not ideal occlusion, with no occlusal interferences and improved facial and dental esthetics (Fig 11). Would slightly better facial esthetics with 2-jaw surgery have been worth the additional risk and cost? The patient and her family were very pleased to have this level of improvement without surgery.

DISCUSSION

The experience with these patients and the outcome data for the complete sample show that satisfactory

orthodontic camouflage with extraction of 1 mandibular incisor can be a way to manage skeletal Class III problems of mild to moderate severity without jaw surgery. For many of these patients, one would expect that a greater change in dentofacial esthetics could have been accomplished with surgical repositioning of one or both jaws, but that would carry with it significantly greater risk and cost.

From comparison with the Connecticut study discussed above, which reported open gingival embrasures in 68% of the patients and 50% as moderately or very noticeable, extraction site preparation did reduce the number of black triangles at the extraction site. This was especially true in our patients under age 20, who had no black triangles and only 3 partially incomplete embrasures—almost a 100% success rate. In the older age groups, as Table II shows, the results were not so favorable. This is clinically significant information, in that it would affect what patients at varying ages should be told in obtaining informed consent.

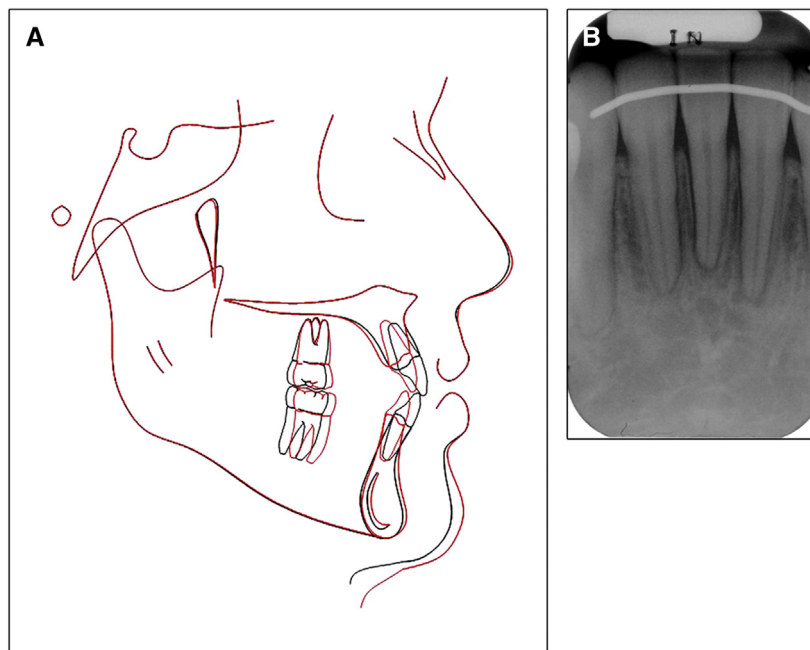


Fig 10. Case 2, continued. **A**, Pre- and post-treatment superimposition of the cephalometric radiographs shows modest maxillary and mandibular incisor retraction. **B**, A post-treatment periapical radiograph shows no loss of crestal bone height between the mandibular left central incisor and mandibular right lateral incisor, which is seen clinically as a full interdental papilla at the extraction site.



Fig 11. Case 2, continued. Patient at completion of treatment, age 19-2. As an alternative to surgery, the extraction of a mandibular right central incisor resulted in functional occlusion and acceptable facial esthetics despite the strong chin.

To some effect, the difference may have been due to a greater number of older patients in the Connecticut study. The age range was almost identical in the 2 studies—age 15–62 vs age 16–62—but the mean age for Connecticut was 26.8, so less than half of their patients but two-thirds of ours were under age 20. They reported no significant age difference in the development of black triangles, and after extraction site preparation we found a large age difference. If the prevalence of black triangles in their young patients was no different from their older ones, it is apparent that extraction site preparation accounted for much of the difference between the 2 studies. It is important to keep in mind that age makes a difference in another way: with aging, the display of mandibular incisors increases, so any areas of loss of papilla height would be easier to see.

Retraction of mandibular incisor teeth after first premolar extraction tends to decrease alveolar bone thickness.¹¹ This has not been observed with extraction of 1 mandibular incisor. Could the tooth movement associated with extraction site preparation lead to long-term periodontal problems? The tipping of the tooth to be extracted could be associated with root resorption, but of course that is irrelevant. The best evidence that there are no periodontal problems associated with extraction site preparation comes from the fact that none were observed in the 2 year or greater follow-up of the patients in this study.

Based on these data, we recommend mandibular incisor extraction for patients over age 40 only if they are fully aware that loss of papilla height might be an esthetic problem after treatment, and do not recommend extraction site preparation if they have this treatment. For those under age 40, informed consent still should include a discussion of papilla height loss, but we do recommend extraction site preparation for them as well as those under age 20.

Is extraction of a mandibular incisor significantly quicker and easier than the alternative of premolar extractions? It seems reasonable that it should be, but there are no good data from direct comparisons, and extraction site preparation does add 2–6 months to the overall length of treatment and some complexity in management. It seems fair to say that the choice of losing 1 vs 2 or 4 teeth should be based more on the expected quality of the result, especially the possible loss of lip support with the greater amount of space closure needed with premolar extraction, than on treatment time.

How generalizable are these findings with Icelandic patients relative to other population groups? There are 2 considerations in evaluating that: the malocclusion pattern in Iceland and the genetics of this population relative to other European population groups.

An epidemiological study in 2007 of the types of malocclusion in Icelandic adults showed a relatively high prevalence of half-cusp or more mesial molar relationships (6.9%) and a low prevalence of anterior crossbite (1.2% in males, 0% in females).¹² Greater mandibular than maxillary incisor crowding would develop when these characteristics are combined, and this pattern was a major reason for choosing 1 mandibular incisor extraction—but this pattern also is seen in other population groups.

Genetic studies have established that the population of Iceland is largely derived from Norwegian and Scotch-Irish ancestors, with the founding males mostly from Norway and the founding females from the British Isles.^{13,14} Icelanders have many similarities in genetic makeup to other European population groups and would not be expected to react to orthodontic treatment differently from most patients of European descent. In short, the data from this study should be reasonably generalizable to other white populations and probably to other populations as well.

CONCLUSIONS

1. Camouflage of a mild skeletal Class III problem is the major indication for this extraction pattern. Removal of 1 mandibular incisor provides excellent dental compensation for the mild skeletal Class III patient who presents with either (1) severe crowding limited to the mandibular arch or (2) a mild anterior crossbite but with good alignment.
2. Loss of interdental papilla height that could impair dental esthetics has been the major problem with incisor extraction, affecting most patients in 1 major previous study. The new extraction site preparation procedure described in this paper prevents this problem in almost all patients under age 20 and decreases its probability in those from age 20–40.
3. About 3% of Icelandic orthodontic patients appear to be good candidates for treatment with extraction of 1 mandibular incisor rather than arch expansion or premolar extraction. The genetic similarity of the Icelandic population to other European groups indicates that our data should be generalizable to other populations of European descent.

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REFERENCES

1. Zhylich D, Suri S. Mandibular incisor extraction: A systematic review of an uncommon extraction choice in orthodontic treatment. *J Orthod* 2011;38:185-95: quiz 231.
2. Ileri Z, Bascifci FA, Malkoc S, Ramoglu ST. Comparison of the outcomes of the lower incisor extraction, premolar extraction and non-extraction treatments. *Eur J Orthod* 2012;34:681-4.
3. Kamal AT, Shaikh A, Fida M. Improvement in Peer Assessment Rating scores after nonextraction, premolar extraction, and mandibular incisor extraction treatments in patients with Class I malocclusion. *Am J Orthod Dentofacial Orthop* 2017;151:685-90.
4. Faerovig E, Zachrisson BU. Effects of mandibular incisor extraction on anterior occlusion in adults with Class III malocclusion and reduced overbite. *Am J Orthod Dentofacial Orthop* 1999;115:113-24.
5. Bolton WA. Disharmony in tooth size and its relation to the analysis and treatment of malocclusion. *Angle Orthod* 1958;28:113-30.
6. Sperry TP, Worms FW, Isaacson RJ, Speidel TM. Tooth-size discrepancy in mandibular prognathism. *Am J Orthod* 1977;72:183-90.
7. Johe RS, Steinhart T, Sado N, Greenberg B, Jing S. Intermaxillary tooth-size discrepancies in different sexes, malocclusion groups, and ethnicities. *Am J Orthod Dentofacial Orthop* 2010;138:599-607.
8. Uribe F, Holliday B, Nanda R. Incidence of open gingival embrasures after mandibular incisor extractions: A clinical photographic evaluation. *Am J Orthod Dentofacial Orthop* 2011;139:49-54.
9. Pithon MM, Santos AM, Couto FS, de Freitas LM, da Silva Coqueiro R. Comparative evaluation of esthetic perception of black spaces in patients with mandibular incisor extraction. *Angle Orthod* 2012;82:806-11.
10. Agenter MK, Harris EF, Blair RN. Influence of tooth crown size on malocclusion. *Am J Orthod Dentofacial Orthop* 2009;136:795-804.
11. Sarikaya S, Haydar B, Cöer S, Ariyürek M. Changes in alveolar bone thickness due to retraction of anterior teeth. *Am J Orthod Dentofacial Orthop* 2002;122:15-26.
12. Jónsson T, Arnlaugsson S, Karlsson KO, Ragnarsson B, Arnarson EO, Magnússon TE. Orthodontic treatment experience and prevalence of malocclusion traits in an Icelandic adult population. *Am J Orthod Dentofacial Orthop* 2007;131:8.e11-8.
13. Helgason A, Sigurðardóttir S, Gulcher JR, Ward R, Stefánsson K. mtDNA and the origin of the Icelanders: Deciphering signals of recent population history. *Am J Hum Genet* 2000;66:999-1016.
14. Helgason A, Sigurðardóttir S, Nicholson J, Sykes B, Hill EW, Bradley DG, et al. Estimating Scandinavian and Gaelic ancestry in the male settlers of Iceland. *Am J Hum Genet* 2000;67:697-717.