
Prevalence of interproximal tooth reduction prescribed as part of initial Invisalign® treatment in 10 orthodontic practices

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Interproximal reduction (IPR) is a therapeutic procedure used during orthodontic treatment and is apparently a commonly incorporated feature in the treatment planning of aligner cases.

The present study investigated the prescription of IPR in the 50 most recently accepted initial aligner treatment plans for each of 10 orthodontic practices. The number of plans incorporating IPR, as well as the magnitude and location of the prescribed IPR, were assessed.

The results showed that IPR was heavily prescribed, with an average of 71% of the 500 reviewed plans receiving IPR as part of that plan. When IPR was prescribed, the amount averaged 2.16 mm per case over 6.92 contact points. The lower anterior teeth had the most heavily prescribed IPR associated with the number of interproximal contacts and the respective amount, while the upper anterior teeth had the least heavily prescribed IPR.

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Introduction

The interproximal reduction of teeth (IPR), also known as enamel stripping, proximal enamel reduction, re-proximation, or slenderisation, is a method that involves the removal of enamel from the contact areas between teeth. The use of IPR has been proposed in the following circumstances:

1. To provide space for alignment when tooth extraction would provide more space than desired and non-extraction treatment would result in undesired labial or buccal arch expansion.¹⁻⁵
2. When individual tooth sizes prevent ideal occlusal relationships including overbite, overjet and Class I molar and canine relationships from being established.⁶⁻⁸
3. To improve the shape or contact areas of teeth for either aesthetic reasons or to minimise open gingival embrasures (OGE).⁹

4. To improve the stability of post-orthodontic treatment alignment, particularly in the lower anterior segment by the flattening of contact points.¹⁰⁻¹³

IPR may be contraindicated in the following circumstances:

1. Poor oral hygiene: biofilms may more readily accumulate on enamel surfaces after IPR, unless adequate tooth polishing has been performed.¹⁴ Adequate polishing after IPR has been shown to leave enamel smoother than untreated enamel.¹⁵⁻¹⁷ However, investigations of the risk of dental caries^{5,18-20} and periodontal problems²¹⁻²³ after IPR have shown that there is no increased risk.
2. Hypersensitive teeth and those with existing reduced interproximal enamel thickness.
3. Poorly aligned contact points: If IPR is performed when clinical access is not ideal, poor proximal contacts and embrasures, and potential aesthetic

problems may result from the removal of enamel from undesired locations.

During clear aligner treatment, IPR may be prescribed by default by the digital treatment plan if the clinician has not specifically adjusted and prevented the use of IPR in their overall clinical preferences. Furthermore, IPR may also be specifically prescribed by the clinician as part of the treatment objective. Regardless of whether IPR is prescribed automatically by the ClinCheck software, or by the Align technician setting up the ClinCheck plan, or is prescribed by the treating clinician, it is the responsibility of the treating clinician to approve the final plan before manufacture of the aligner sequence.

Several recent studies have quantified clinical IPR performance associated with aligner treatment. An *in vivo* study by Blandy et al.²⁴ who assessed the IPR performed in 20 cases from a single orthodontic practice, it was found that overall enamel reduction was under-achieved by 55.9% per tooth surface. More extensive studies by De Felice et al.²⁵ on 40 cases from 10 orthodontists, and Weir et al.²⁶ on 250 cases treated by 10 orthodontists found similar results. Weir et al. reported a 56% under-achievement of clinical IPR when compared to the digital treatment plan. This contrasts with the finding of Lagana et al.,²⁷ who found complete accuracy in the performance of IPR on 30 patients from a single practice.

A shortfall in the amount of enamel removed could compromise the desired clinical outcome by failing to provide sufficient reduction in arch perimeter to allow the teeth to fit precisely within the aligner, particularly if IPR was prescribed overnumerous contact points. While shortfalls in aligner treatment outcomes compared to the prescribed outcomes have been regularly reported,^{28–30} it remains unknown whether the clinical performance of IPR is a contributing factor.

While clinical performance of planned IPR is one factor, the prevalence of IPR prescription in aligner treatment is poorly reported and the prevalence of IPR as a component of orthodontic treatment in general, is unknown. Kailasam et al. commented that IPR is common during clear aligner therapy but evidence to support this statement was not provided.³¹ De Felice et al. reported on IPR for four consecutive patients treated with aligners from each of 10 orthodontists.²⁵

IPR was prescribed in 36 of the 40 patients, for an overall prevalence of 90%. Literature data are lacking in regard to the prevalence of IPR applied in fixed appliance treatment.

Therefore, the present study aimed to quantify the prescription of IPR in accepted initial aligner treatment plans using a large sample size of patient data obtained from multiple practitioners. Data on the prevalence, combined with data on accuracy, may allow a general assessment of the effect of IPR on treatment outcomes.

Methods

All data for the study were obtained from the Australasian Aligner Research Database (AARD) of aligner cases, which has been collected for research purposes. As of July 2020, AARD held the patient databases from 12 orthodontic practices, and totalled approximately 10,000 cases. As the present study follows on from Weir et al.,²⁶ it was decided to obtain the necessary data from the same 10 orthodontic practices, potentially enabling the prevalence of IPR prescription to be matched with the quantification of IPR clinically performed. While Weir et al.²⁶ assessed the clinical performance of IPR in 25 cases from each orthodontic practice which had completed an initial treatment sequence of aligners, the present study used the 50 most recently accepted ClinCheck treatment plans for initial orthodontic treatment from each orthodontic practice. The treatment plans were accessed and all prescribed IPR accepted as part of all plans was recorded. Participating orthodontic practice databases were randomly assigned alphabetic labels to de-identify participants for statistical analysis.

When IPR was prescribed, the data were divided into the level of IPR, the number of sites in each arch for which it was prescribed, and the zone of prescription for each arch. The zones of prescription for each arch were: Anterior (IPR prescribed from distal of canines mesially around the arch) comprising a maximum of seven contacts; and Posterior (mesial and distal to the second premolars) consisting of a maximum of four contacts (Figure 1).

Inclusion criteria:

1. Initial ClinCheck treatment plan accepted for the treatment start.
2. All patients were 18 years of age or older.

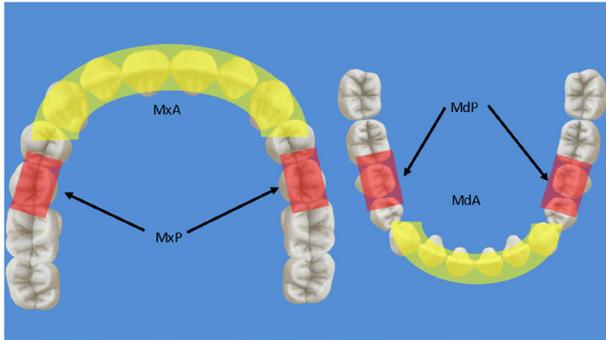


Figure 1. IPR Zones: MxA includes all contacts from the distal of the canines forward in the maxilla; MxP includes contacts mesial and distal of the premolars in the maxilla. MdA includes all contacts from the distal of the canines forward in the mandible; MdP includes contacts mesial and distal of the premolars in the mandible.

3. Cases treated without the extraction of teeth or exfoliating deciduous teeth.
4. Aligner treatment was planned for both upper and lower dental arches.

Results

IPR was found to have been prescribed in the initial accepted treatment plans of 71% of the 500 reviewed cases, with a range of 38% to 98% between the orthodontic practices. The prescribed total IPR averaged 2.16mm over 6.92 sites per treatment plan (Figure 2; Table I).

Table II shows the IPR prescribed by zones. Mandibular Anterior IPR (MdA) was prescribed in 5.03 of 7 sites and averaged 1.54 mm. The prescription for the Maxillary Anterior zone (MxA) was 1.02 mm from 3.33 of 7 sites, while in the four sites in the posterior zones of each arch, Maxillary IPR (MxP) averaged 0.84 mm from 2.54 sites and Mandibular IPR (MdP) averaged 1.03 mm over 2.76 sites.

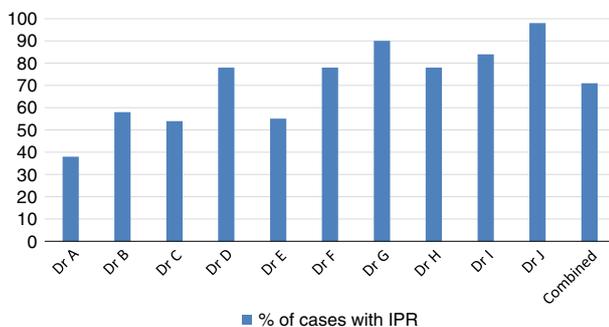


Figure 2. Overall IPR prescription (% of cases with IPR, and where prescribed, the average amount and the number of sites prescribed).

Table I. Overall IPR prescription (% of cases with IPR, and when prescribed, the average amount and the number of sites prescribed).

	% of cases with IPR	IPR/patient overall (mm)	Sites/patient overall	IPR/site (mm)
Dr A	38	2.71	8.42	0.32
Dr B	58	1.43	5.31	0.27
Dr C	54	2.29	6.26	0.37
Dr D	78	2.87	9.67	0.30
Dr E	55	1.86	5.81	0.32
Dr F	78	1.79	5.13	0.35
Dr G	90	2.56	8.20	0.31
Dr H	78	2.72	7.34	0.37
Dr I	84	0.86	3.86	0.22
Dr J	98	2.61	8.47	0.31
Combined	71	2.16	6.92	0.31

Discussion

IPR was prescribed in 71% of the 500 accepted initial ClinCheck plans from the 10 orthodontic practices. This compares with a 90% prevalence of IPR in the 40 cases reported by De Felice et al.²⁵

Relative consistency was observed between the 10 practices in the present study, in instances when IPR was prescribed, the amount prescribed, the locations where IPR was prescribed, and the number of sites for which IPR was prescribed. When the examined orthodontic practices prescribed IPR, most requested approximately 0.3 mm per site over a total of 7 sites of a potential 22 sites available from the interproximal contacts of the first permanent molars forwards. This resulted in a average total of 2.1 mm of IPR prescribed for any case in which tooth size reduction was part of the initial treatment plan.

The lower anterior region was the zone of greatest IPR prescription, with 5 of the potential 7 sites anteriorly between the canines undergoing an average total of 1.5 mm IPR. By contrast, the maxillary anterior region was the zone where the least IPR was prescribed, with, on average, only 3.3 out of 7 sites having IPR prescribed. IPR prescription related to the sites and quantities was similar for both upper and lower posterior zones, with slightly more IPR prescribed in the lower posterior areas. These differences may be a reflection of the location of tooth size discrepancies,

Table II. IPR Prescription by number of sites and average quantity for all orthodontic practices by zone.

	MxA sites	MxA IPR	MxP sites	MxP IPR	MdA sites	MdA IPR	MdP sites	MdP IPR
Dr A	5.38	1.73	2.00	0.73	6.40	2.03	4.00	1.20
Dr B	2.77	0.79	0.00	0.00	5.04	1.33	2.00	0.60
Dr C	4.06	1.36	0.00	0.00	5.21	1.98	2.50	1.15
Dr D	3.36	1.00	2.60	0.86	5.45	1.46	3.10	1.07
Dr E	4.00	1.30	0.00	0.00	5.33	1.68	4.00	1.80
Dr F	2.33	0.83	2.00	0.47	3.81	1.35	2.00	0.60
Dr G	4.47	1.37	2.78	0.90	6.09	1.86	2.71	0.92
Dr H	3.33	1.22	2.75	1.08	5.69	1.94	2.64	1.54
Dr I	1.72	0.40	0.00	0.00	3.16	0.70	2.00	0.40
Dr J	3.48	0.96	1.00	0.20	5.25	1.71	2.31	0.77
Combined	3.33	1.02	2.53	0.84	5.03	1.54	2.76	1.03

as mandibular anterior Bolton tooth-size excesses are nearly twice as commonly seen than in the maxillary anterior region.³²⁻³⁴

The present study investigated only IPR accepted in the initial prescription. It is likely that clinicians often prescribe additional IPR in refinement aligner requests, in response to changes in treatment goals, the presence of open gingival embrasures detected after initial alignment or due to changes in treatment goals. Therefore, the number of cases with IPR, the amounts prescribed, and sites prescribed are likely to be much higher by the completion of treatment after further aligner orders. Huanca recently reported an average of 2 to 7 additional aligner orders per case.³⁵

Align allows clinicians to order additional aligners for up to five years after the initial treatment plan has been accepted. Therefore, it was not possible to determine the total prevalence of IPR, as the present study investigated the prescription characteristics for the 50 most recent clinical cases to determine the most up-to-date data from those practices.

While the present study revealed that IPR is commonly prescribed in aligner treatment in the 10 examined practices, there were no data regarding IPR prescription in matched fixed appliance cases. The reason for the lack of fixed appliance data can only be speculated but may highlight a mechanical difference in aligner treatment during which there is no spontaneous proclination or expansion due to aligner mechanics. Unless these movements are programmed into the digital plan, a space shortage may more often

be reported as IPR. The actual clinical performance of IPR, related to the amount of reduction, for the 25 cases from each of the orthodontic practices, was 44% of the amount prescribed.²⁶

Combining prevalence data with the quantification data derived from the 10 practices, although for a different set of patients, indicates that when IPR is prescribed, at an average of 2.1 mm per case, it is performed to 44% of the amount prescribed, leading to an expected average shortfall of 1.2 mm per case. This corresponds to the study by De Felice et al., who reported that the average difference between planned and performed IPR in their sample was 0.55 mm in the upper arch and 0.82 mm in the lower arch.²⁵ The effect of this shortfall on clinical treatment outcomes is unknown, although it is likely that, the more IPR prescribed for a given case, the more likely that undesirable treatment outcomes will be seen. The undesirable outcomes might include incomplete alignment, unprogrammed tooth intrusion and failure to achieve desired overjet control, although further studies will need to be undertaken to establish any association between a given amount of IPR shortfall and specific undesirable treatment outcomes.

As a retrospective study of prescribed IPR, the present study has limitations. Although the analysed cases were randomly selected, clinicians are likely to have differing case selection criteria for the treatment of patients using aligners and IPR. This may explain the differences in IPR prescription seen between

the orthodontic practices. Similarly, treatment philosophies differ between orthodontists, which may result in preferences for alignment with expansion, proclination or extraction rather than IPR, or vice versa. Personal preferences may also determine the willingness of the prescribing orthodontist to perform IPR in certain zones, for example, Orthodontists B, C, E and I prescribed no IPR at all in maxillary posterior zones. The precise reasons for IPR prescription for each of the 500 cases in the present study remain unknown. Future studies that quantify the total IPR prescription for completed aligner treatments by orthodontists, as well as those prescribed by non-specialists may reveal further features of aligner treatments, and, in combination with data describing the accuracy of clinical IPR, may help to explain requirements for additional aligner orders and challenges in the finishing of cases. Studies reporting on IPR prevalence in fixed appliance cases would also be of interest, especially if significant differences in IPR prescription are found between the two orthodontic treatment modalities.

Conclusions

It appears that IPR is commonly prescribed as part of aligner treatment in the initial accepted plan. The reasons for prescription in the initial plan are unknown and likely to vary between orthodontic practices and according to the specific features of the case.

IPR is therefore a significant feature of aligner treatment undertaken by orthodontists and, when combined with data on the accuracy of clinical IPR performance, may indicate the need for careful continuing assessment and performance of interproximal reduction to achieve desired clinical outcomes.

Conflict of Interest

The authors declare that there is no conflict of interest.

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