Recordings of Chewing and Border Movements in Typical Malocclusions

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Recordings of jaw movements are often used to assess the influence of functional disturbances on individual malocclusions. Divergent paths of opening and closing might indicate reciprocal clicking due to a disc displacement; limited border movements could be caused by an anteriorly or medially displaced disc without reduction. Functional disturbances during mastication may be identified by irregular chewing movements with reduced anterior guidance on each working side.

It must be remembered, however, that there are wide individual variations in chewing movements.[1] Malocclusions are not always reflected in pathologic chewing patterns,[2] and normal occlusions do not always show normal chewing patterns.[3] Therefore, it may be advisable to analyze jaw movements in certain cases after orthodontic treatment, in addition to the traditional grading of casts and other records.[4]

Although several studies have recorded disturbances of chewing movements in patients with TMD symptoms,[5-8] few authors have correlated these disturbances with restricted chewing movements in malocclusions before and after orthodontic treatment.[1] This article describes the changes in recorded chewing and border movements in two typical orthodontic cases.

Recording of Jaw Movements

Jaw movements were recorded with a light-emitting-diode mandibular tracking device (Visi-Trainer Model 3*).[3,9,10] Chewing movements were recorded for 20 seconds, with the patient chewing gum on both sides using natural strokes in the horizontal plane, then the frontal plane, and finally the sagittal plane (Fig. 1).

Normal border movements show a well-defined intercuspal position, smooth and equal lateral excursions, and straight and coincident opening and closing paths (Fig. 2A). Normal chewing movements demonstrate a smooth, rhythmic cycle; the gliding tooth contacts in closing coincide with the border movement as anterior guidance on the working side, and the closing point is consistent with the maximum intercuspal position (Fig. 2B).

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Fig. 1 Jaw movements recorded by Visi-Trainer jaw-tracking device with light-emitting diode attached to mandibular incisors.

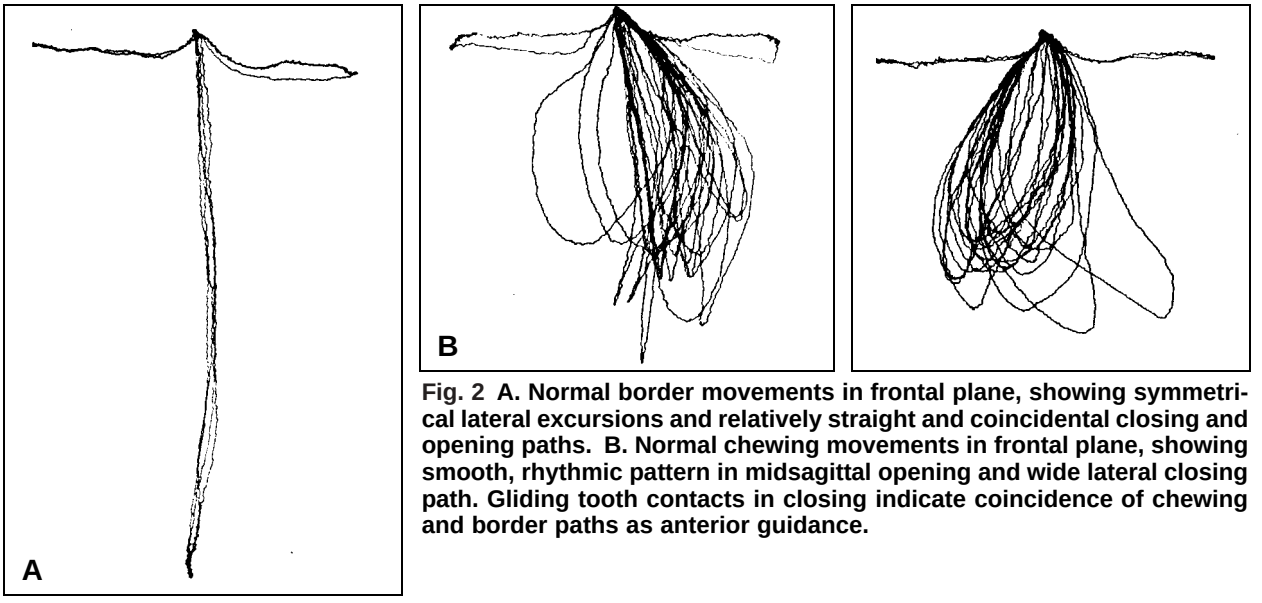


Fig. 2 A. Normal border movements in frontal plane, showing symmetrical lateral excursions and relatively straight and coincidental closing and opening paths. B. Normal chewing movements in frontal plane, showing smooth, rhythmic pattern in midsagittal opening and wide lateral closing path. Gliding tooth contacts in closing indicate coincidence of chewing and border paths as anterior guidance.

Fig. 3 Case 1. 13-year-old female with Class II, division 2 malocclusion before treatment.

Case 1

A female patient, age 13 years, 8 months, presented with a Class II, division 2 malocclusion and a severely brachyfacial pattern (Fig. 3). She had a complete overbite and a buccal crossbite in the premolar region. The mandibular buccal segments were collapsed on both sides. Because of her lingually inclined maxillary incisors and severe overjet, she displayed 3-4mm of gingiva when she smiled. Facial photographs indicated a short lower face height and a marked labiomental groove. The patient was not aware of an unstable

TABLE 1
CASE 1 CEPHALOMETRIC DATA

	Before Treatment	After Treatment
Facial Axis	90°	90°
Facial Depth	85°	85°
Mandibular Plane	17°	16°
Convexity	2mm	2mm
L1-APo	–5mm	0mm
Lower Lip	–1.5mm	–3mm
Upper Lip	–1mm	–3mm
Lower Facial Height	42°	42°
Mandibular Arc	45°	48°
Gonial Angle	107°	108°
N-Ans	56mm	56mm
Ans-Me	61mm	62mm

Fig. 4 Case 1. After 29 months of treatment.

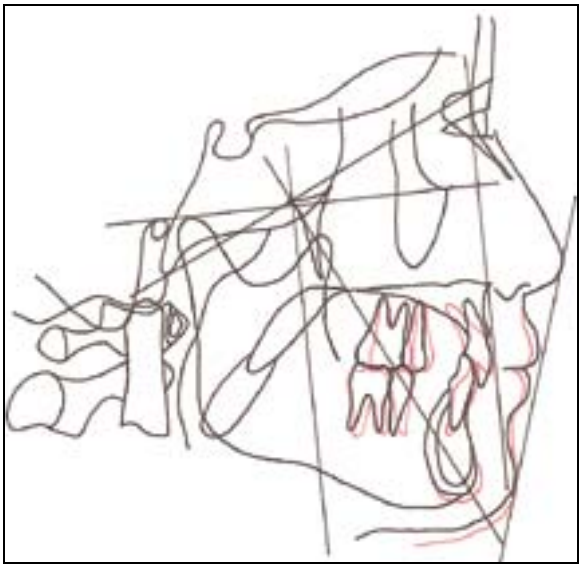


Fig. 5 Case 1. Superimposition of pre- and post-treatment cephalometric tracings.

occlusion or restricted mandibular movement.

Cephalometric analysis confirmed the short lower face (Table 1). The maxillary incisors were excessively retroclined, and the mandibular incisors were extrusive relative to the occlusal plane.

A bite plate was prescribed for the first phase of treatment. At age 15, active treatment began with intrusion of the maxillary incisors using a utility arch. A removable appliance was placed for expansion of the collapsed mandibular arch. Four months later, a leveling archwire was placed in the maxillary arch, and the maxillary first premolars were extracted for correction of the anterior protrusion.

Appliances were removed and retainers were delivered after 29 months of active treatment (Figs. 4,5). The patient was pleased with the improvement in her gummy smile.

Recordings of lateral border movements before treatment indicated a steep intercuspal position consistent with a severe deep bite (Fig. 6). The patient showed normal gliding tooth contacts along the border movement in closing and no contact opening on the chewing side.[3,11] However, the chewing cycle showed a rectilinear motion between steep lateral border movements, and in the sagittal plane, the chewing cycles were concentrated on the posterior side of the border movement.

After treatment, the angle of lateral border movements changed from steep to normal, due to the correction of the deep bite (Fig. 7). The chewing stroke was traced with good rhythm and changed from a rectilinear to a circular motion in the horizontal and frontal planes. The left side chewing movement was similar to the movement before treatment in the frontal plane. (The patient did not have a preferred side for mastication before treatment, but preferred the left side after treatment.) In the sagittal plane, the path of opening and closing became more anterior, due to the correction of the overjet.

Case 2

A 23-year-old female presented with the chief complaint of anterior crossbite and unstable posterior occlusion (Fig. 8). She had been treated from ages 10-12 with full fixed appliances and a chin cup to restrict mandibular growth.

Clinical evaluation showed a protrusive chin, open bite, bilateral crossbite, and maxillary arch-length deficiency. The profile was concave, with mandibular protrusion. Functional examination revealed a disturbance in movement of the left TMJ, with a reciprocal click, but the patient did not perceive any dysfunction. Cephalometric analysis confirmed the skeletal Class III, open bite, and mandibular protrusion (Table 2).

Active treatment was begun after one year, following extraction of the maxillary first premolars and surgery for the mandibular prognathism. The patient has also undergone myofunctional therapy to correct her lower tongue position and tongue thrust.

Orthodontic treatment lasted 22 months (Fig. 9). The patient perceived an improvement in mastication with both the anterior and posterior teeth.

Recordings of jaw movements before treat-

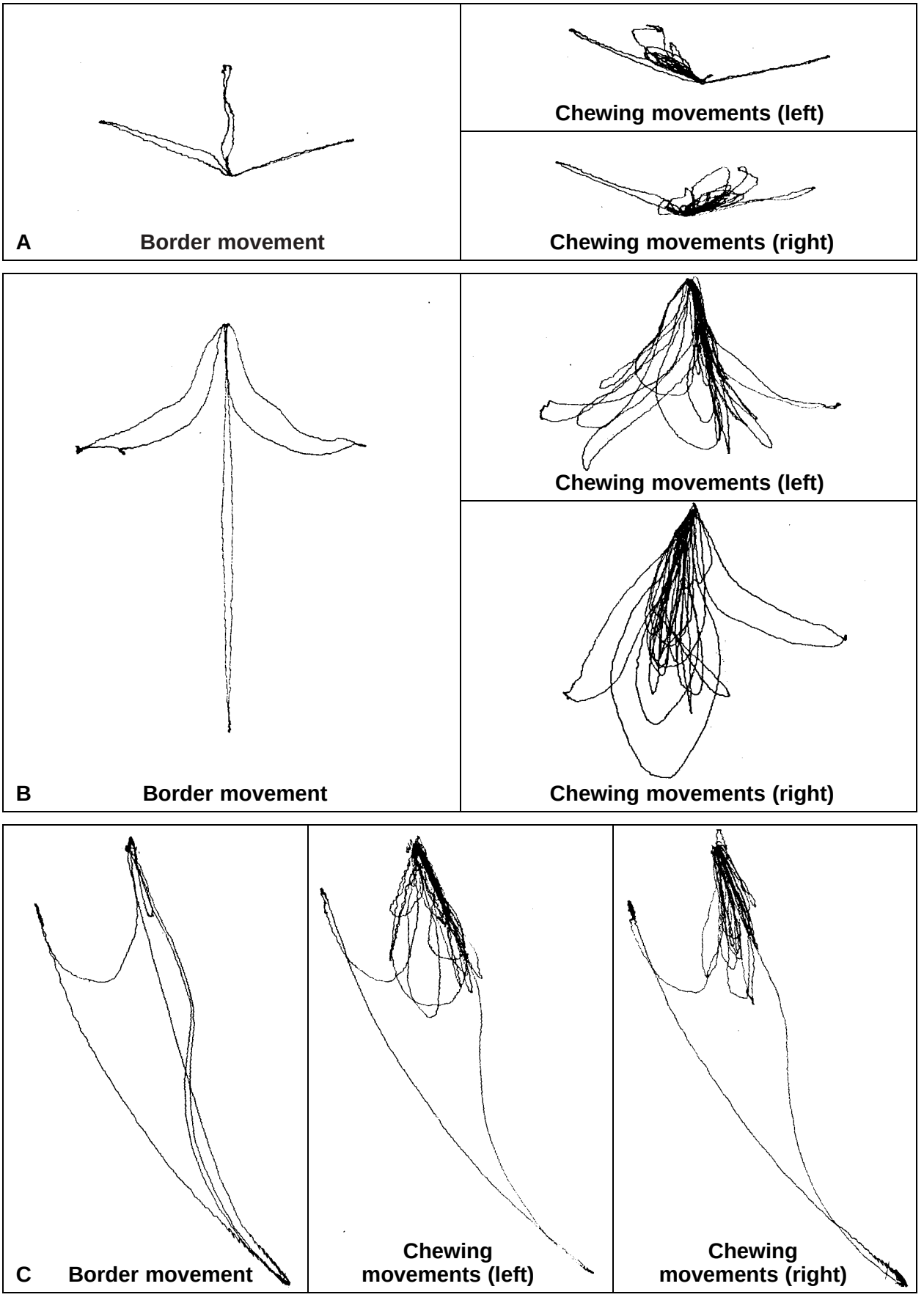
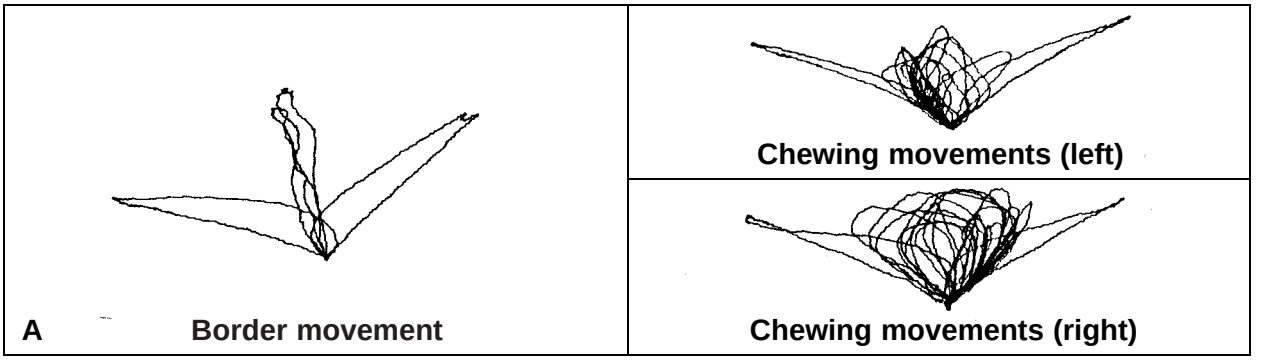
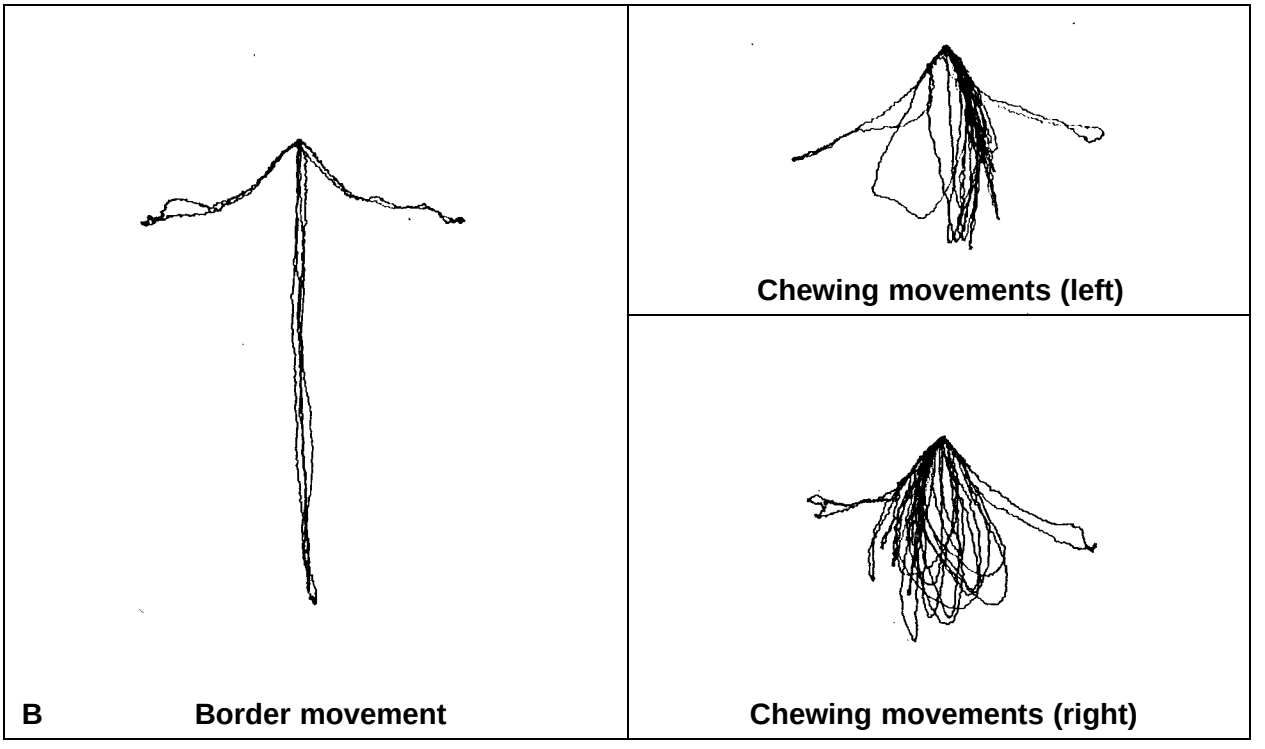


Fig. 6 Case 1. Border and chewing movements before treatment. A. Horizontal plane. B. Frontal plane. C. Sagittal plane.





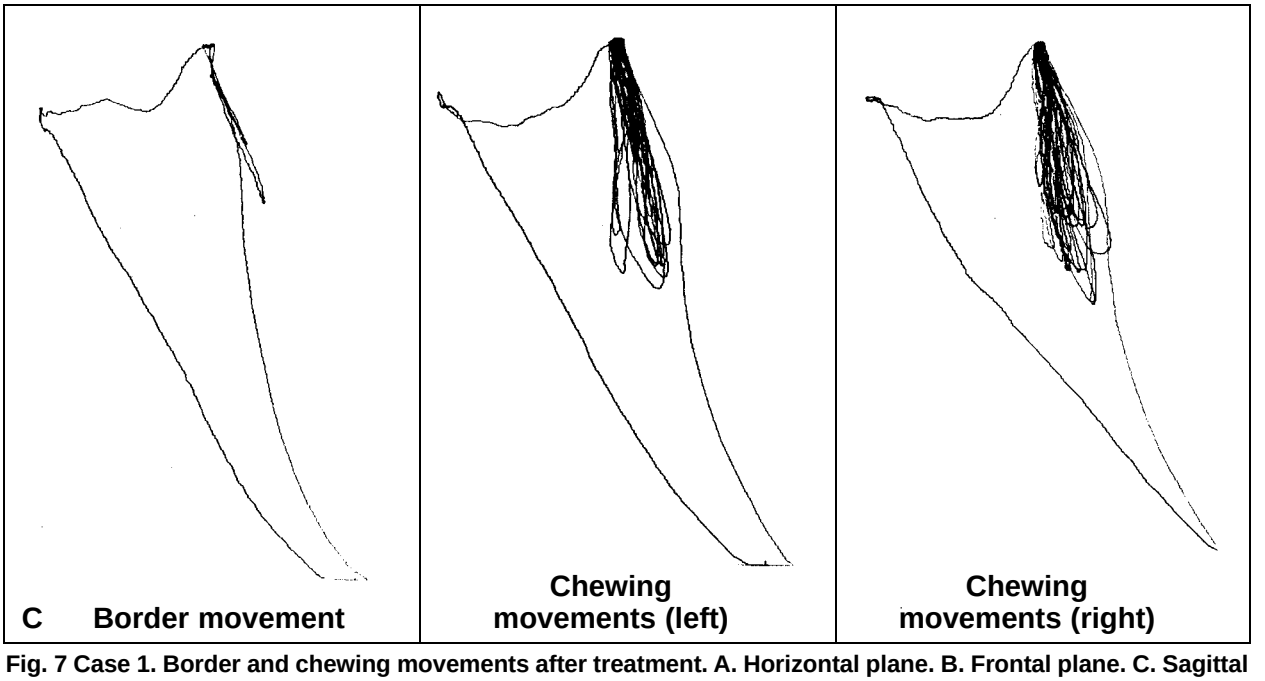


Fig. 7 Case 1. Border and chewing movements after treatment. A. Horizontal plane. B. Frontal plane. C. Sagittal plane.

Fig. 8 Case 2. 23-year-old female with anterior crossbite before treatment.

ment showed a marked limitation of lateral excursion and a leftward shift of forward border movements in the horizontal plane (Fig. 10). The opening-closing path was irregular and twisted in the frontal plane, reflecting the reciprocal click. Chewing movements were rectilinear on each working side. The habitual right chewing side showed a slightly more circular motion than the left.

After treatment, lateral and forward border movements were still limited, but the opening and closing strokes became straighter with the elimination of the reciprocal click in the left TMJ (Fig. 11). Chewing movements were teardrop-shaped,

Fig. 9 Case 2. After 22 months of treatment.

combined with some circular motions. The closing path did not have a gliding contact along the lateral border movement as anterior guidance on each working side.

Magnetic resonance imaging of the TMJ was obtained after treatment in both intercuspal and open positions (Fig. 13). The sagittal MRIs showed anteriorly displaced discs without reduction on the right side and with reduction on the left. Coronal images showed a medial displacement of the disc relative to the condyle on both sides.

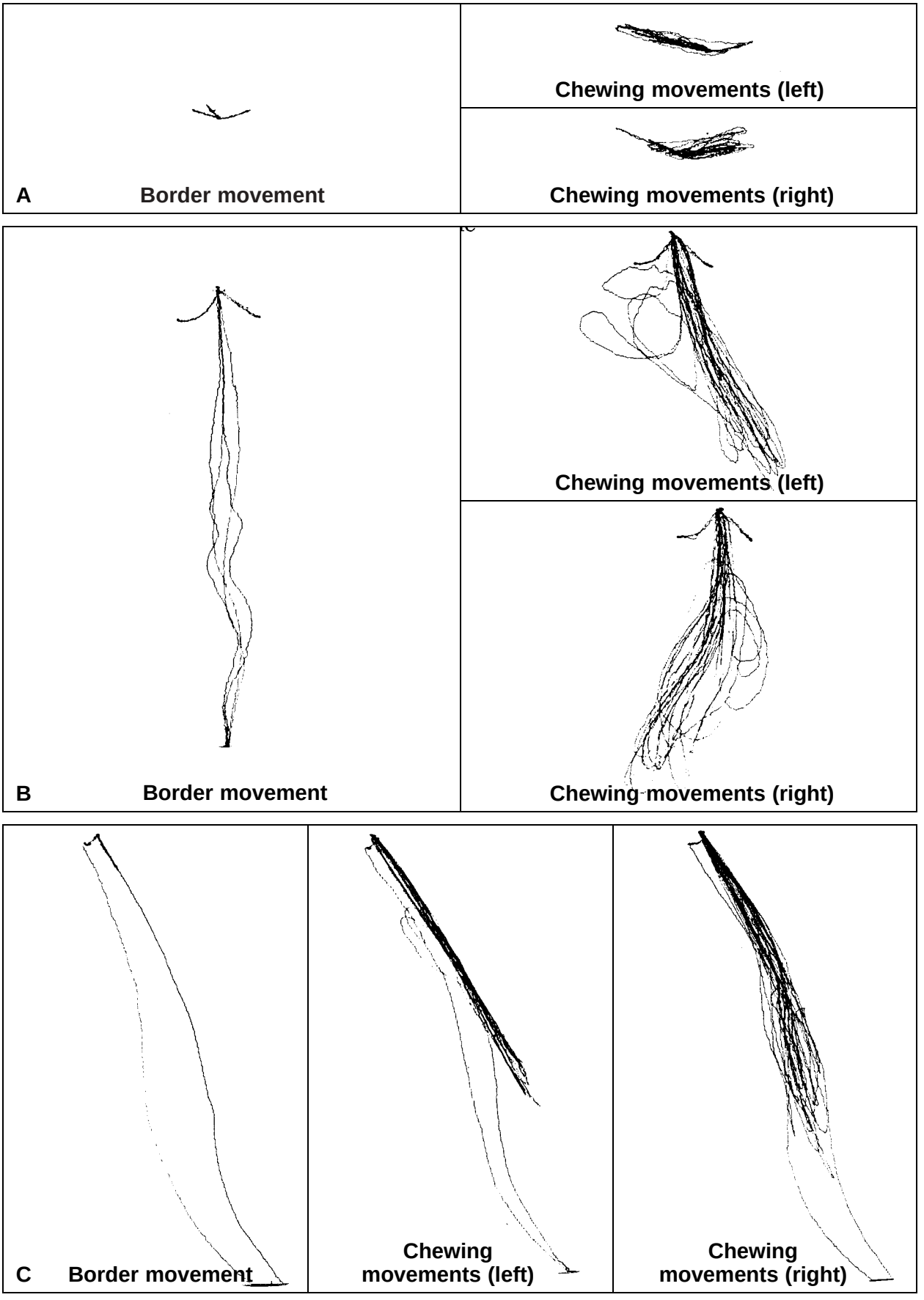


Fig. 10 Case 2. Border and chewing movements before treatment. A. Horizontal plane. B. Frontal plane. C. Sagittal plane.

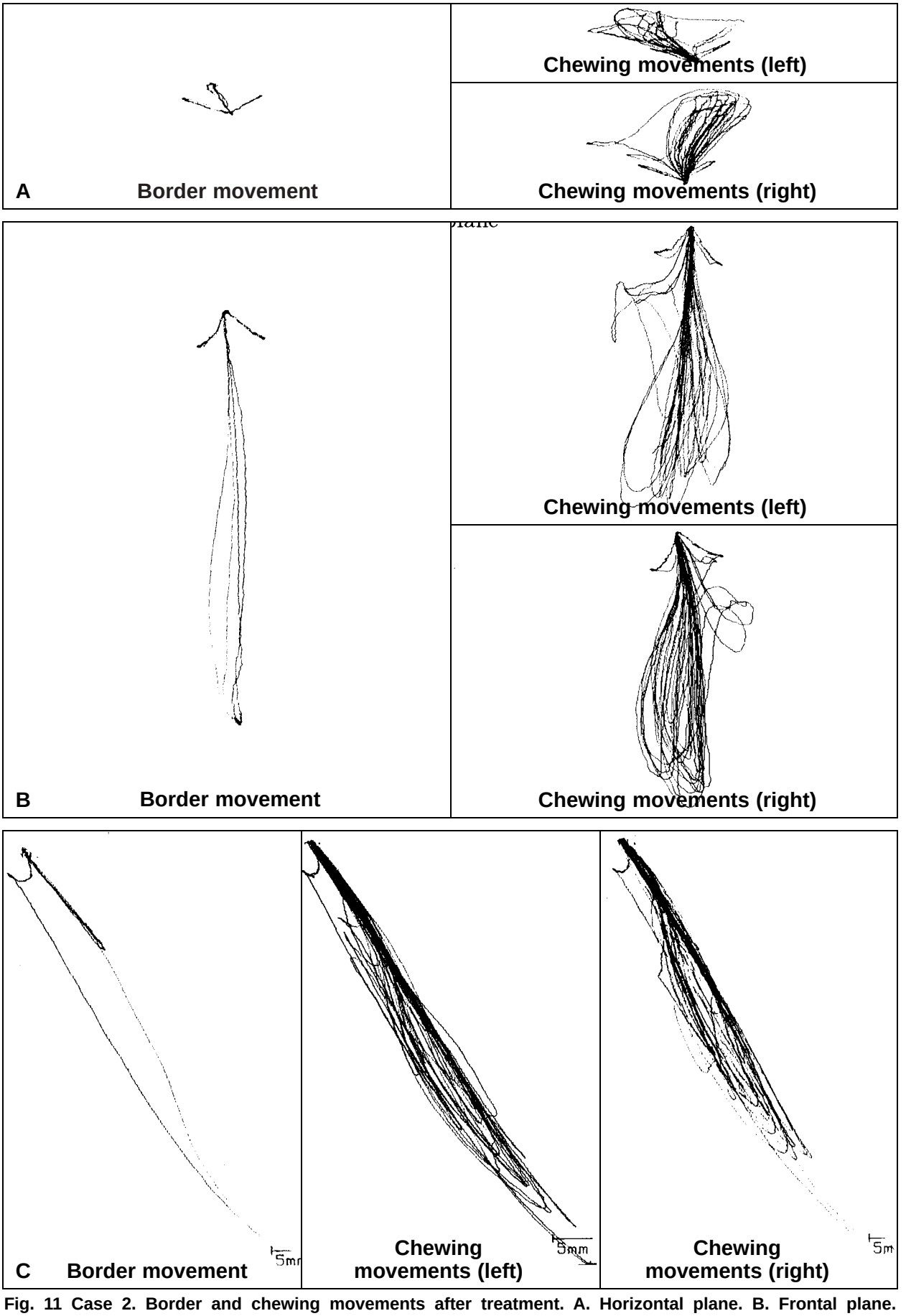


Fig. 11 Case 2. Border and chewing movements after treatment. A. Horizontal plane. B. Frontal plane. C. Sagittal plane.

TABLE 2
CASE 2 CEPHALOMETRIC DATA

	Before Treatment	After Treatment
Facial Axis	95°	91°
Facial Depth	94°	88°
Mandibular Plane	24°	31°
Convexity	0mm	4.5mm
L1-APo	6mm	2mm
Lower Lip	0.5mm	–1mm
Upper Lip	–6mm	–2.5mm
Gonial Angle	130°	133°
Corpus Length	79mm	72mm
N-Ans	58mm	58mm
Ans-Me	71mm	71mm
Cd-Pg	131mm	122mm

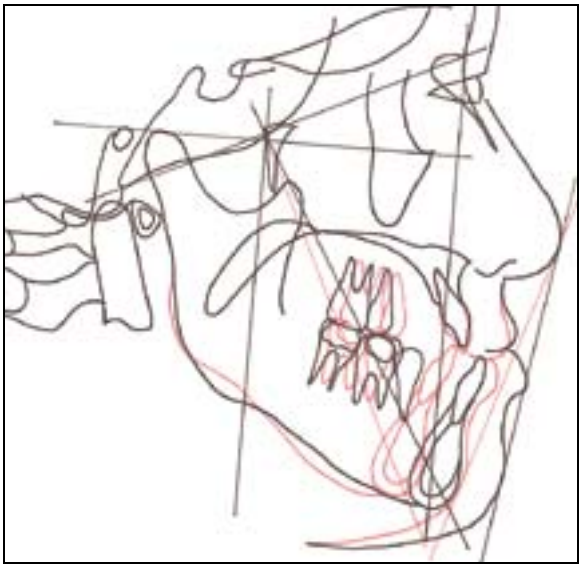


Fig. 12 Case 2. Superimposition of pre- and post-treatment cephalometric tracings.

Discussion

Case 1 was a typical malocclusion with a collapsed mandibular arch, a non-occluding posterior segment, and a severe overjet. Such extreme overjet could be associated with abnormal function and TMD, although most studies do not support this relationship.[12] Pretreatment recordings of jaw movements did not show the limited, abnormal path associated with deep bites. In the sagittal plane, however, the chewing cycle showed a characteristic pattern along the posterior border movement, indicating that the severe overjet caused the condyle to be thrust posteriorly against the fossa during mastication[13] (Fig. 6). After treatment, the steepness of lateral border movements was reduced, and the patient could obtain good anterior guidance without functional disturbance.

The angle of lateral border movements at intercuspal position can be affected by various factors, including tooth alignment, arch coordination, and morphology of the TMJ. Smooth, regular border movements can indicate interference of the posterior segment on the working or balancing side. Before treatment, this patient's chewing movements displayed the narrow and rectilinear form characteristic of restriction by the extreme overjet of the maxillary incisors. After treatment, chewing movements changed to the more normal circular pattern. However, the choppy pattern on the left suggested that the condyle on the balancing side could not translate laterally because of a disturbance of the anteromedially displaced disc. This suggests that measurements of mandibular movement can be helpful in evaluating condyle-disc movements following correction of deep bite.

Case 2 was a skeletal Class III with an open bite and with occlusion only on the second molars. Lateral and forward border movements showed the restricted translation of the condyle from the fossa due to the medially displaced disc.[14-16] Opening without limitation showed a winding path that could reflect either condylar movement with a medially and anteriorly displaced disc or the stretching of the posterior attachment to the disc.[17,18]

Before treatment, the preferred right side had a chewing cycle with a more circular motion than on the left side. This could indicate that the right condyle failed to obtain the fundamental

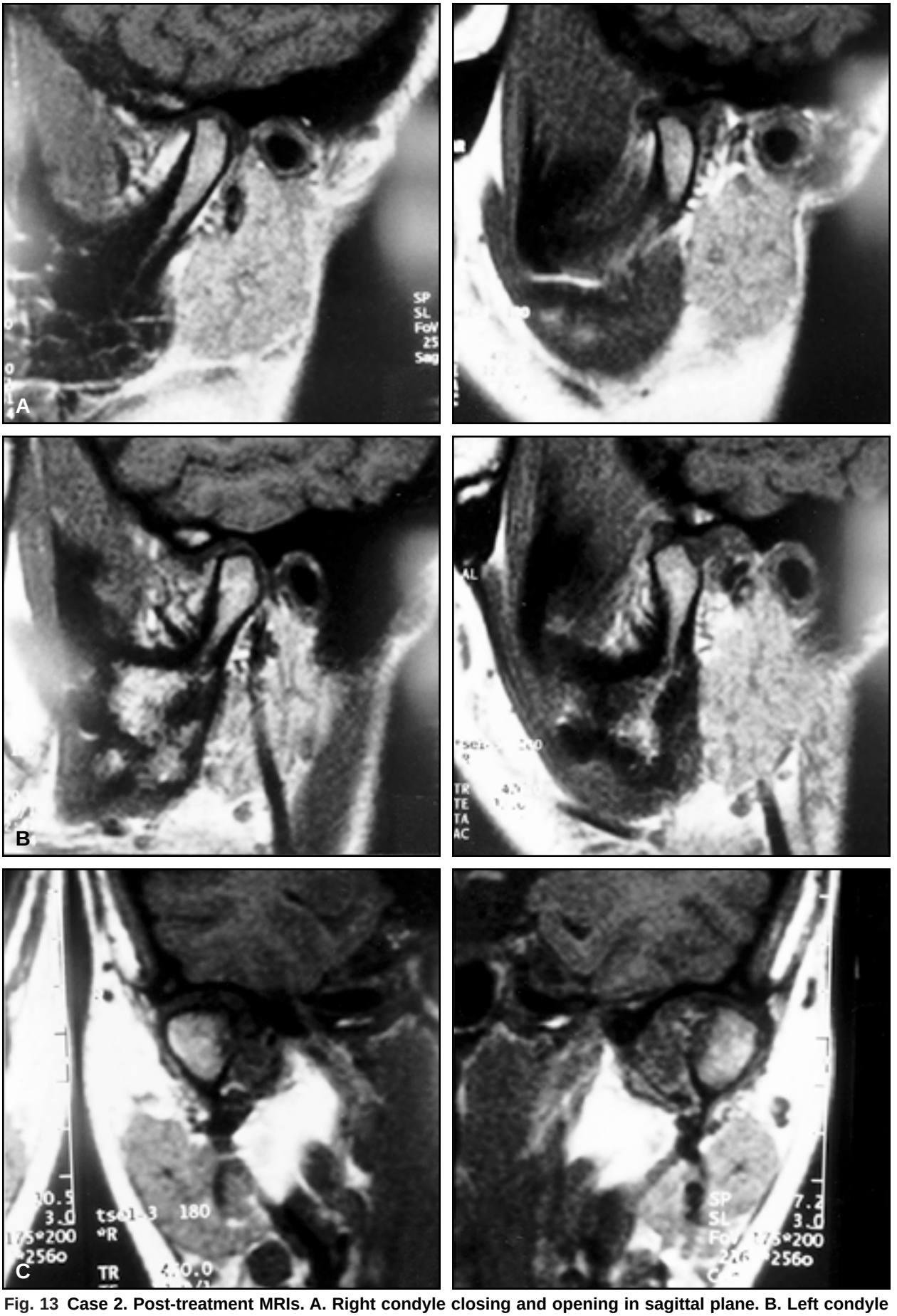


Fig. 13 Case 2. Post-treatment MRIs. A. Right condyle closing and opening in sagittal plane. B. Left condyle closing and opening in sagittal plane. C. Right and left condyles in coronal plane.

movements as a balancing side during mastication on the left. However, the post-treatment MRI showed disc displacement without reduction of the right condyle. Mongini reported that patients with TMD typically have restricted and divergent jaw movements on the preferred side of mastication.[19] Ito and colleagues showed a patient who had conditioned himself to chew hard foods on the side with a deranged disc; they hypothesized that the disc was more likely to slip out of place when food was chewed on the deranged side.[20]

Our MRIs showed that the patient had anteriorly and medially displaced discs, with a small condyle on the right and a flattened condyle on the left. Arnett and colleagues reported that dysfunctional remodeling can be related to an inadequate host-adaptive capacity, coincidental internal derangement, excessive parafunction, or unstable occlusion.[21] Schellhas and colleagues suggested that a progressive anterior open bite may develop in some children and adults with bilateral joint degeneration and arrested proximal mandibular segments.[22] They emphasized that the clinician must be aware of the structural symptoms underlying TMD.

Conclusion

Chairside recording of jaw movements, as described in this article, can be useful in assessing functional disturbances before and after orthodontic treatment.

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