Journal of Oral Biology and Craniofacial Research 13 (2023) 424–428

Contents lists available at ScienceDirect

Journal of Oral Biology and Craniofacial Research

journal homepage: www.elsevier.com/locate/jobcr

The inferior alveolar nerve at the proximal fragment during bilateral sagittal split osteotomy - Is there need to reposition to distal fragment?

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ARTICLE INFO

Keywords:
Inferior alveolar nerve injury
BSSO
IAN recovery
BSSO complications

ABSTRACT

Inferior alveolar nerve (IAN) injury is most common in bilateral sagittal split osteotomy (BSSO) cases. The present standard is to always reposition the IAN from the proximal fragment to the distal fragment during surgery. This study aims to assess the severity and incidence of postoperative injury and the recovery of the inferior alveolar nerve in proximal fragment entrapment.

Methods: — A total of 35 patients (70 BSSO osteotomies) with mandibular deformities requiring movements equal to or less than 6 mm were selected. Twenty out of 70 osteotomies had IAN on the proximal fragment (Group 1) while splitting. Group 2 included 20 osteotomies with IAN on the distal segment in the same patients. Therefore, 15 patients who had IAN on distal segments on both sides were excluded from this study. All the BSSO procedures were performed by the same surgeon. Postoperative recovery and follow-up were performed on the immediate 1st postoperative day and at 3-, 6- and 12-month intervals. The nociception (pin-prick discrimination) test and mechanoreceptive tactile skin test with cotton fibrils were performed by a third clinician who was blinded to the procedure to assess IAN sensation.

Conclusion: There was no significant difference between the groups in the recovery of IAN sensation after 6 months and the 1-year period. Hence reposition of IAN from the proximal segment to the distal segment during BSSO surgery may not be mandatory if the required movement is within 6 mm. This avoids unnecessary manipulation of the IAN over the proximal fragment.

1. Introduction

Orthognathic surgery is known to be associated with many complications, but among these complications, inferior alveolar nerve injury is the most frequent complication in bilateral sagittal split osteotomy. Bilateral sagittal split osteotomy is the most versatile osteotomy performed for mandible deformity corrections.

The incidence of IAN (inferior alveolar nerve) deficits after mandibular osteotomies varies from 0% to 100%. Deficits include numbness or unusual sensations in the lower lip, chin, teeth, and gingiva. Paresthesia is usually transient but may be permanent.[1]

Entrapment of the IA nerve in the proximal fragment occurs in 39% of BSSOs. A buccally positioned IAN requires manipulation of the nerve, which increases the risk of nerve injury and postoperative neurosensory disturbances (NSDs)[1](2).

There are many factors associated with the entrapment of IAN to the proximal fragment. Factors such as the thickness of the buccal cortex plate from the IAN, the height of the bone

From the nerve to the crest, and the impacted tooth's presence affect the IAN's entrapment to the proximal segment.[2] Therefore, during bilateral sagittal split osteotomy, it is always not possible to prevent this complication. There are many modifications in the BSSO procedure technique in the literature to avoid this complication. One such modification is splitting the lower border and the classical BSSO procedure to keep the lingual plate intact. The incidence of IAN nerve entrapment into the proximal fragment is also reduced.[4]

Clinical experience often shows that despite perfectly successful splitting of the ramus without any visible damage to the IAN, sensation in the lower lip and chin may be severely disturbed immediately after the operation[4]

In this study, IAN nerve was left in the proximal segment whenever it occurred during the BSSO. Repositioning of the nerve to the distal fragment was not performed. This is based on the concept of minimal nerve manipulation during surgery.[5]

This study aims to assess the severity and incidence of postoperative injury and the recovery of the inferior alveolar nerve in proximal fragment entrapment cases and assess postoperative recovery.

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https://doi.org/10.1016/j.jobcr.2023.04.001
Received 24 October 2021; Received in revised form 9 January 2023; Accepted 3 April 2023

2. Materials and methods

This prospective observational study was conducted on a group of patients who underwent the BSSO procedure for mandibular deformity from December 2016 until 2020.

Simple random sampling has been used. Because out of 70 BSSO osteotomy sites every patient had the equal chance IAN nerve either being present on distal or proximal fragment.

The total number of patients who underwent BSSO osteotomy was 35 (70 osteotomies). Out of these 70 osteotomies, we found the IAN nerve entrapped in the proximal fragment in 20 osteotomy sites (Group 1). Then, we considered including 20 BSSO osteotomies as a control group where IAN was on the distal segment (Group 2). We excluded 15 patients (30 osteotomy sites) in this study in which IAN was on the distal fragment on both sides of osteotomy.

The main inclusion criteria was Patients who underwent BSSO procedure with or with maxillary osteotomy. All the patients were of ASA grade 1. To be precise only patients with IAN entrapped on the proximal fragment were selected for the study group with IAN on distal fragmant as control group Patients with any other comorbidity or any nerve disorders were excluded from the group.

Written informed consent was taken from all the participants.

The ethical committee of the university approved the study protocol. IRB- SGTU/FDS/MDS/21/1/dated Dec 6, 2016).

All 20 patients were examined before surgery with pinprick test for nociception, and subjective symptoms for normal IAN function to be compared post surgically. All patients were free of any neurological disorders before surgery.

Out of 20 patients, 12 patients underwent Bijaw surgery (BSSO and Lefort 1 osteotomy), and 8 patients underwent BSSO alone. Among these, 13 were female patients, and 7 were male ("as shown in Supplemental Table 2").

Preoperative Assessment—Preoperative examination included case history, study models, orthopantamograph, lateral cephalometric radiograph, and cephalometric analysis. All patients were treated with presurgical orthodontics to perform orthodontic decompensations. Once the final treatment was ready, the face bow record was performed for all cases, and intermediate and final surgical splints were performed on the study models.

Surgical Procedure-All patients underwent the Hunsuck-Dalpont modification BSSO procedure under general anaesthesia.[6] A 701 straight fissure bur along with 5 mm and 7 mm osteotomes were used for all osteotomy cuts. The channel retractor was used on the lingual side to retract the IAN nerve at the level of Lingula while making the lingual osteotomy. A single 2.5 mm width with 4 Hole Gap titanium miniplates was used for fixation of the ostetomised BSSO segments in the new position (Fig. 3). All surgical procedures were carried out by a single surgeon.

Osteotomy sites with IAN nerve entrapment on the proximal segment is shown (Figs. 1 and 2). The IAN entrapped in the proximal fragment was left in the same place and was not manipulated to shift to the distal fragment in all the cases before the fixation into the new position. All the osteotomy sites were fixed in the new planned position using a single 2 mm 4 hole with a gap titanium plate in all the patients (Figs. 3 and 4). Furthermore, in some patients, 6 holes with gap mini plates were used.

In our protocol, preoperative antibiotics and 8 mg dexamethasone were given to all patients 1 h before surgery. The patients were kept in the ICU for 1 day and shifted to the postoperative care ward for the 2nd and 3rd days. All patients were discharged to go home on the 4th day.

The postoperative evaluation of IAN function was performed for all the patients at 1 postoperative day, 3 months, 6 months, and 1-year.

Subjective & Objective type nerve assessment methods–The patient's subjective examination findings are given the maximum priority irrespective of the objective method testing.[7] **Subjective Sensation**.– All the patients were evaluated by a trained clinician (blinded about the surgical technique) during each follow-up visit on the 1st postoperative day, 3 months, 6 months, and 1 year. The presence of paresthesia, hypo- or hyperesthesia was indicated on a paper with a diagrammatic representation and marked.[8]

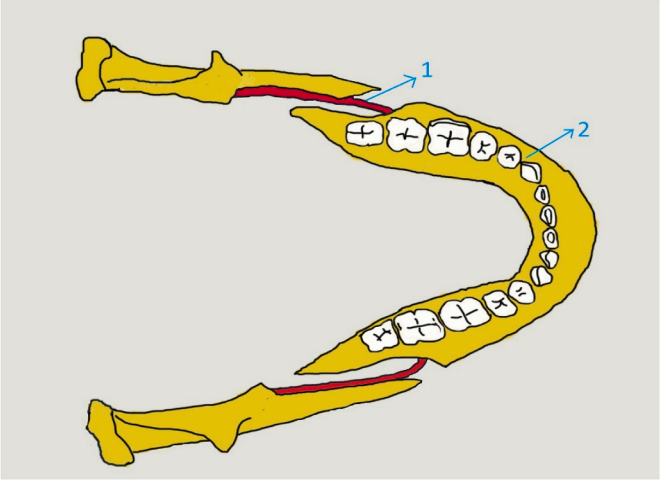


Fig. 1. 1- Inferior alveolar nerve entrapped in the proximal fragment after BSSO split.

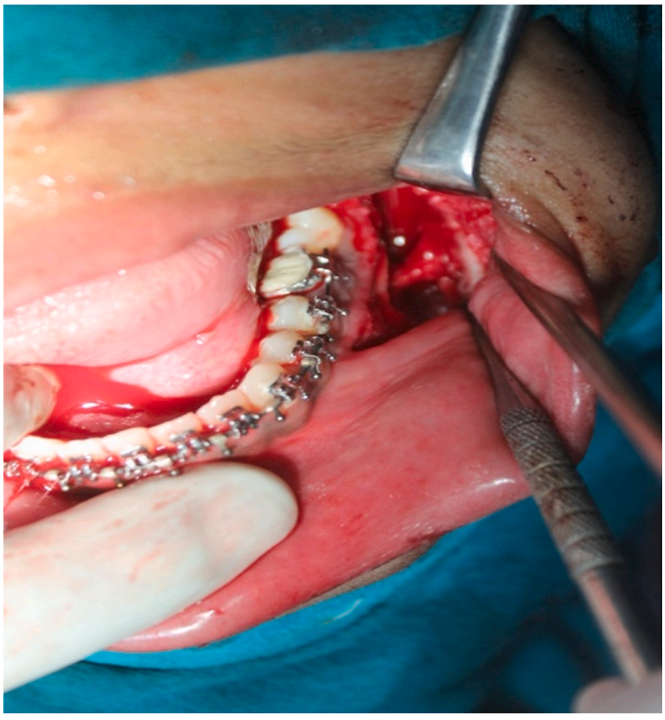


Fig. 2. Clinical picture showing Inferior Alveolar nerve entrapped in Proximal fragment.

Clinical sensory testing methods—Clinical sensory testing was performed by a trained clinician who was blinded to the surgical technique.

1 Nociception (pin-prick discrimination) test for the lower lip area ("as shown in Supplemental Table 3"). This method was used to pinch the skin with a sharp dental probe. Sharp pain/sensation recorded by the patient represented normal pain (normal sensation), moderate pain (Mild pareasthesia) and Mild pain (Moderate paresthesia)

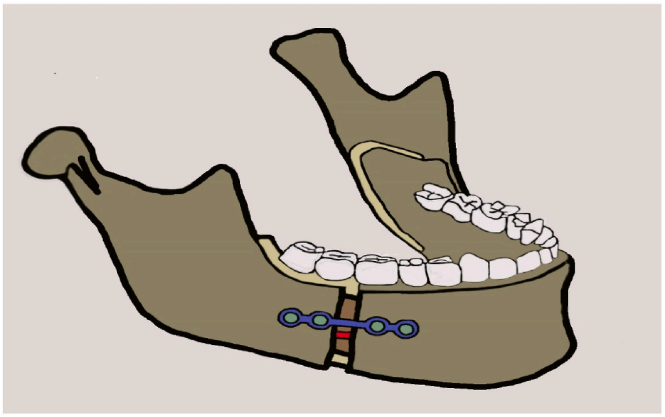


Fig. 3. Final Position stabilized with 4 hole Titanium Miniplate.

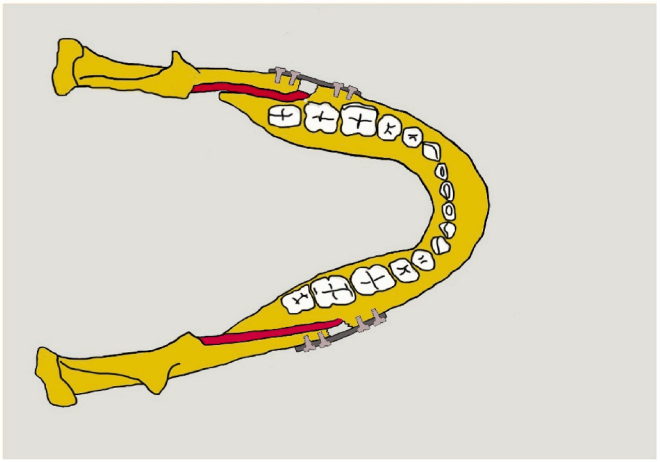


Fig. 4. Final position of Inferior alveolar nerve and Mini plate after fixation of Bilateral sagittal split osteotomy.

2 Objective screening of the sensibility of the lower lip and chin area was performed with a simple mechanoreceptive neurological test using cotton swabs[9] (Supplemental Table 4)

This is the light touch method performed by using cotton wisps and gently touching the skin over the lower lip. This detection threshold felt by the patient was represented diagrammatically over the records.

Sensory neurography seems to be the most sensitive diagnostic tool that can verify even subclinical old injuries.[7]

2.1. Statistical analysis

Statistical analysis of the data was performed using the Statistical Package for Social Sciences, version 23.0 software (SPSS, Chicago, IL). All variables were divided into categorical, continuous and ordinal variables. Categorical variables were further subdivided into dichotomous and polychotomous variables. Groups I (proximal) and II (distal) were compared for each of these variables. Pearson χ^2 or Fisher's exact test was used to analyze two dichotomous categorical variables or a polychotomous categorical variable with a dichotomous categorical variable. The Friedman's Two-Way Analysis of Variance by Ranks followed by Dunn's post-test was used to compare three or more matched groups. For all statistical tests, a 95% confidence interval was used, and $P < 0.05$ was considered statistically significant.

3. Results

A total of 20 patients [07 (35%) males and 13 (65%) females] formed the study population. Seventeen (85%) patients were aged less than 25 years, and the remaining 03 (15%) patients were above 26 years [mean 26.7 ± 4.10] years; age range-21 to 34 years. Bilateral sagittal split osteotomy (BSSO) was performed on 08 (40%) patients, and bijaw surgery (Lefort 1 with BSSO) was performed on 12 (60%) patients (Supplemental Table 1). However, both the gender and age distributions were not significant, p = 0.608 and p = 0.612, respectively.

The Pin Prick Sensation Test (Graph 1) and Tactile Touch Sensation Test (Graph 2) results showed that the recovery rate progressively improved over a period of time from the first postoperative day to one year. Seventy percent of the patients in Group 1 regained sensation within the 6-month follow-up, and 95% recovered at 1 year post-operatively according to both tests. In Group 2, the recovery at 6 months was 90% and 100% at 1 year postoperatively. The difference between post op recovery in both groups was not significant (p = 0.614). Only one patient in Group 1 had mild paresthesia at the end of 1 year, which resolved at the 15th month postoperatively.

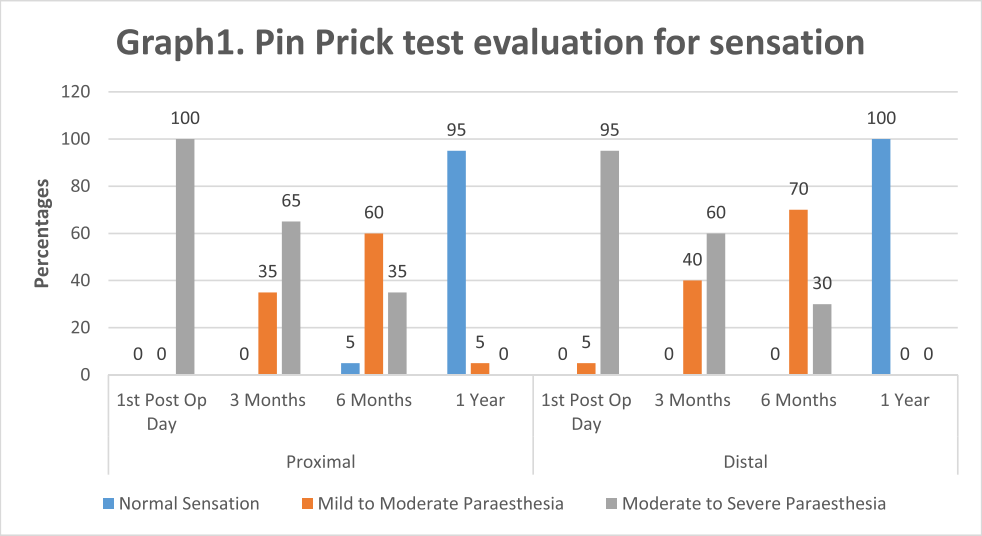
Friedman's Two-Way analysis of Variance by Ranks was used for both Pin Prick Test Sensation (Table 1) and Tactile Touch Sensation Test (Table 2). The observations showed statistically significant differences in sensation after one-year post treatment procedure in all groups across multiple observational time - period. The post-operative recovery follows up from the 1st post-operative day to one year was continuously done for all patients. Fortunately, there were no missing patients and all were cooperative during the entire study period. In Pin Prick Sensation Test (Table 1) there was a statistically significant difference of post-operative recovery between the first post-operative period and 1 year in proximal segments [Right - χ value = 23.649; p = 0.001 and Left - χ value = 14.674; p = 0.002]. In the distal segment this significant difference in post-operative recovery was observed in between the first post-operative day with both three months and six months follow up period [Right - χ value = 27.900; p = 0.001 and Left - χ value = 32.126; p = 0.001].

In Tactile Touch Sensation Test (Table 2), statistically significant difference was found between first post-operative day and 1 year in both proximal [Right - χ value = 24.120; p = 0.001 and Left - χ value = 13.773; p = 0.003] and distal right [χ value = 24.481; p = 0.001] segments. In distal left segment significant difference was observed between first post-operative day with 3 months and also six months follow up time period [χ value = 29.779; p = 0.001]. As per the data shown in graph 1 and graph 2 there is 95% recovery in group 1 and 100% recovery in group 2. So there is no statistically significant difference between the inter group.

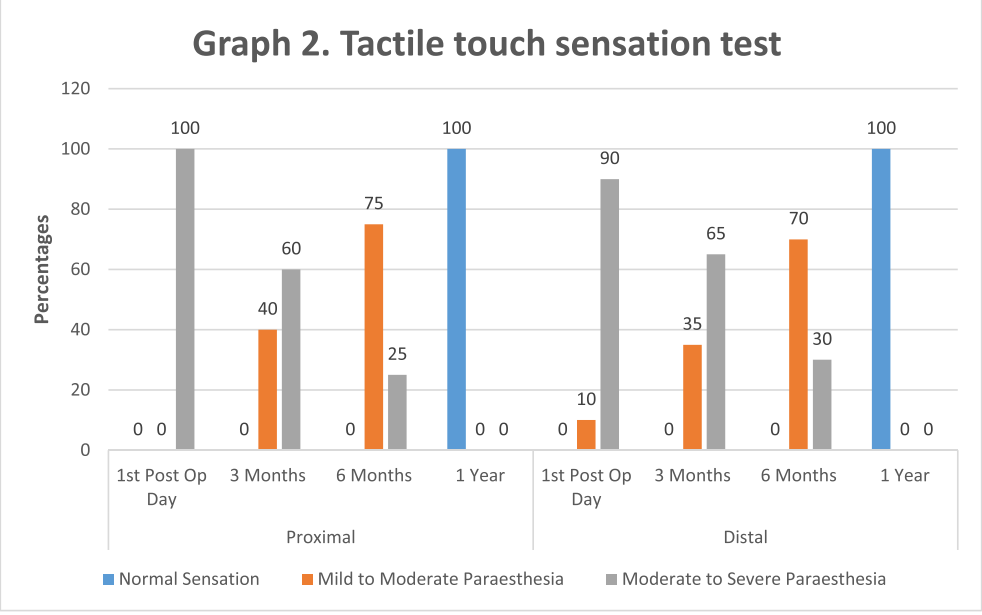
4. Discussion

IAN nerve injury is quite common and one of the most expected complications in BSSO osteotomy.[10] Iannetti et al. studied complications in orthognathic surgery on 3236 patients and stated that IAN injury is the most common among all other complications that match our findings. Moreover, in 92% of cases, IAN injury occurs during osteotomy drilling and splitting of the segments.[10] This is in coordination with our study where we had the incidence of 100% of our patients with IAN nerve paresthesia on the first post operative day in both the groups.

Even soft tissue dissection during exposure of the osteotomy site and tissue retraction before the BSSO split may also lead to postoperative nerve dysfunction.[4,11] It is a well-known fact that the IAN needs to always be associated with the distal or medial dentate segment after the BSSO osteotomy split. As per the literature (C. politis et al., 2014), 30–40% of the time, the IAN nerve becomes trapped in the proximal fragment after BSSO split.[3] These findings were slightly different in our study, with 28.5% of IAN nerves trapped in the proximal segment after splitting.



Graph 1. Pin Prick test evaluation for sensation.



Graph 2. Tactile touch sensation test.

Table 1
Pin Prick test.

Groups	Follow up period				Chi square	P value
	First post op	3 months	6 months	1 year		
Proximal Right	3.15[a]	2.60[a]	2.28[a]	1.98[b]	23.649	0.001
Proximal Left	2.90[a]	2.58[a]	2.30[a]	2.22[b]	14.674	0.002
Distal Right	3.25[b]	2.68[b]	2.15[ab]	1.92[a]	27.900	0.001
Distal Left	3.38[b]	2.68[b]	2.10[ab]	1.85[a]	32.126	0.001

Test Applied: Related Samples Friedman's Two-way Analysis of Variance by Ranks. Same letters in rows indicate no statistically significant difference.
$p < 0.05$ – Statistically significant.

Table 2
Tactile touch sensation test.

Groups	Follow up period				Chi square	P value
	First post op	3 months	6 months	1 year		
Proximal Right	3.18[a]	2.50[a]	2.35[a]	1.98[b]	24.120	0.001
Proximal Left	2.88[a]	2.52[a]	2.42[a]	2.18[b]	13.773	0.003
Distal Right	3.15[a]	2.65[a]	2.28[a]	1.92[b]	24.481	0.001
Distal Left	3.32[b]	2.62[b]	2.15[ab]	1.90[a]	29.779	0.001

Test Applied: Related Samples Friedman's Two-way Analysis of Variance by Ranks. Same letters in rows indicate no statistically significant difference.
$p < 0.05$ – Statistically significant.

Bocelli et al. (2002) stated that there is a high possibility of IAN injury during the BSSO procedure either during osteotomy or placement of screws or during manipulation of fragments. Moreover, he mentioned that it takes at least 6 months for nerve function to return to normal, similar to our study.[12]

Tabrizi et al., in 2020 stated that there is a significant influence of factors such as the thickness of the buccal cortex, presence of impacted molars, and height of the mandible, which determine the entrapment of the IAN to the proximal or distal fragment.[2] These factors might have played a role in our study, as we had 28.5% of our cases where the IAN was trapped in the proximal fragment.

Mensink et al. stated that in 2014, a systematic review stated that the use of osteotomes and burs for splitting in BSSO resulted in more IAN paresthesia, which matches our study, as we have used osteotomes and burs for splitting.[13]

In situations where the IAN nerve is trapped in the proximal fragment, it will be under stretch only while splitting and spreading the segments. Once the fragments are fixed in their planned final position, the nerve's stretching effect will be minimized. Moreover, this would be normal in 3 months post surgery. This is why the degree of IAN paresthesia was relatively more in group 1 in the first postoperative 3-month period in our study. Nevertheless, we limited the movement of segments, either advancement or setback, to 6 mm or less in all our cases. So, this could be one limiting factor.

No literature has mentioned the results of leaving the IAN nerve in the proximal fragment. Therefore, it is very evident based on the available literature that intraoperative manipulation is one of the etiological factors for postoperative paresthesia. Keeping this factor in mind, we left the IAN nerve in one proximal segment. As per our results, we did not find any significant difference between the groups in the 1st day, 3 months, 6 months, or one-year postoperative paresthesia. This finding very well states that there is no added injury or more injury if the IAN nerve is left in the proximal segment. The degree of paresthesia was greater in the first 3 months postoperatively than in the control group. However, this difference was not statistically significant (P value was more than 0.05).

5. Conclusion

Even though the degree of paresthesia of IAN nerve injury was more in Proximal fragment group in comparison to IAN Distal fragment group-there was no significant difference between the recovery of IAN paresthesia after 6 months and the 1-year period. Hence, there is no need to manipulate and reposition the IAN bundles trapped in the proximal fragment to distal segment during the BSSO split. But this fact is limited to mild to moderate deformity skeletal cases where the movement is limited to 6 mm or less. Hence this may not be applicable to extreme deformity cases requiring larger movement. However, more long-term studies with larger samples are required for more authenticity of this technique.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jobcr.2023.04.001.

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