

# Open reduction and internal fixation without rigid maxillomandibular fixation: evidence based or merely a surgical dictum? A comparative pilot study on 24 cases

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**Abstract. – OBJECTIVE:** The objective of the study was to evaluate the results and immediate postoperative complications following open reduction and internal fixation of mandibular fractures with or without postoperative maxillo-mandibular fixation

**MATERIALS AND METHODS:** The study spanned over a period of 24 months, extending from October 2015 to October 2017. The study sample comprised 24 subjects between the age range of 18 to 65 years. They were randomly divided into two groups: Group A included subjects in whom open reduction and internal fixation was followed by maxilla-mandibular fixation for 15 days, and Group B subjects in whom only open reduction and internal fixation was done, followed by immediate mobilization. The outcomes evaluated were swelling, pain, simplified oral hygiene index and occlusion. The subjects were followed for all these outcomes on 1<sup>st</sup>, 7<sup>th</sup> and 15<sup>th</sup> days. The occlusion was assessed for 5 days. Any other intra/post-operative complications were additionally noted.

**RESULTS:** There was no statistical difference between the groups for swelling, pain and occlusion. The patients with postoperative maxilla-mandibular fixation had poorer oral hygiene when compared to the other group ( $p < 0.001$ ).

**CONCLUSIONS:** The use of maxilla-mandibular fixation post open reduction and internal fixation seems to offer no additional benefits to the patients. According to the results of the

study, this traditional surgical dictum seems to be used by the surgeons due to the lack of any scientific evidence. However, further studies should be conducted to confirm this statement.

*Key Words:*

Mandibular Fractures, Internal fixators, Maxillary fractures, Open fracture reduction, Fracture fixation, Maxillo-mandibular fixation, Intermaxillary fixation.

## Abbreviations

AO: Arbeitsgemeinschaft für Osteosynthesefragen foundation; OHI-S: simplified Oral health index; MMF: Maxillomandibular Fixation; OR/IF: Open Reduction and Internal Fixation; POD: post-operative day; VAS: Visual analogue scale.

## Introduction

The mandibular bone is commonly involved structure in craniofacial trauma owing to its prominent position in the maxillofacial skeleton. It is a horse – shoe shaped bone that articulates with the cranial base through the temporomandibular joints. Its structure can be compared to an archery bow, being strongest at the centre in the region of the symphysis and relatively weak to-

wards the end, in the area of the condyles, where it most often fractures<sup>1,2</sup>.

The management of the lower jaw fractures has undergone constant evolution throughout the ages. In 1492 Guglielmo Salicetti, was the first to introduce maxilla-mandibular fixation (MMF), and the technique was later popularized by Gilmer<sup>3</sup> wherein the two jaws were tied to each other restoring the premorbid occlusion, and also providing bone healing<sup>2</sup>. The constant need for MMF while managing fractures through this approach presented major problems to the patients in terms of trismus, weight loss, oral hygiene maintenance and social problems<sup>4</sup>.

Open reduction and internal fixation (OR/IF) were first introduced by Buck<sup>5</sup>. During this procedure, the fractured segments were visualized, reduction was established using intraoperative maxilla-mandibular fixation and then the fractures were plated. This technique was welcomed by the surgeons as it led to a decrease in the overall rates of non-union and infections and allowed for a faster return to function<sup>6</sup>.

In studies done by Champy et al<sup>7</sup>, the importance of plating along the ideal lines of osteo-synthesis on the mandible using smaller, 2.0 mm mini-plates was evaluated. Stated that if this system was strictly followed, post-operative MMF could be avoided and it was possible to practice immediate mobilization. Despite these studies, many surgeons still practice postoperative MMF and believe that osteo-synthesis does not provide the stability needed for healing. The routine use of MMF is however questionable as theoretically mini-plate fixation along the lines of osteo-synthesis should provide sufficient rigidity to allow for adequate fixation and healing.

Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation principles of internal fixation of the craniomaxillofacial skeleton trauma and orthognathic surgery recommends MMF in cases like; temporary fragment stabilization in emergency cases before definitive treatment, intraoperative fixation in combination with internal fixation, use as tension band, long-term fixation in non-surgical management, fixation of avulsed teeth and alveolar crest fragments<sup>8,29</sup>. But, majority of the surgeons prefer to practice MMF for almost any intervention involving this region. Therefore, it is needed to assess if the use of MMF is supported by scientific evidence or is it merely a surgical dictum. This study aims to assess if any difference exists in the immediate postoperative complications following open re-

duction and internal fixation of mandibular fractures with and without postoperative MMF. Thus, the aim is to assess whether or not maintaining subjects on maxillomandibular fixation after open reduction and internal fixation confers any advantages.

## Materials and Methods

A pilot prospective study was conducted at A.B. Shetty Memorial Institute of Dental Sciences and K.S. Hegde Charitable Hospital Mangalore, Karnataka. The study was approved by local institutional ethical committee with the registration number ABSM/EC68/2015. The study subjects were patients reporting to the Department of Oral and Maxillofacial Surgery, who were diagnosed with mandibular fractures on the basis of clinical and radiographic examination, that required open reduction and internal fixation. The subjects were randomly divided into two groups. A table of random numbers was used wherein each patient was sequentially allotted a number and assigned a group corresponding to the previously generated table. Group A composed of 12 subjects in whom ORIF was followed by MMF for 15 days, and Group B included 12 subjects in whom only ORIF was done followed by immediate mobilization. AO-COIJAC Software Version 4.0 Comprehensive Injury Automatic Classifier (A classification system developed by AO foundation) was used to describe the type of fractures included. The type of mandibular fractures included was according to the AO foundation classification code mandible 91.P.C.A.B.S.B.A.C.P and P (Right) H.N.B<sup>8,14</sup>. An informed consent was obtained from each subject prior to enrolling them in the study. However, subjects with systemic diseases who were not fit for General anaesthesia, edentulous subjects, patients with severely comminuted fractures, i.e., fracture of any anatomic area of the mandible consisting of 3 or more fragments and subjects not willing to participate in the study were excluded.

### *Preoperative Assessment*

The demographic details of the patient were registered, the site of the fracture and the preoperative facial swelling was recorded by the mean of a nine – line measurement using a plastic measuring tape as described by Dongol et al<sup>9</sup>. The measurements were taken pre-operatively, and post-operatively on day 1, day 7 and day 15.

The subjects underwent OR/IF according to the protocol suggested by Champy et al<sup>7</sup>. The operating team was blinded to the study and therefore did not know whether or not the subject was to be placed postoperatively on MMF. Postoperatively the subjects were randomly divided into two groups using the previously described method of table of random numbers and were assessed on post-operative day (POD) 1, 7 and 15 for the following parameters.

Swelling was assessed using a mean (mm) of nine-line measurements taken with the help of a plastic measuring tape across the face, Line 1, right gonion to right lateral canthus of eye; line 2, left gonion to left lateral canthus; line 3, right tragus to right commissure of lip; line 4, left tragus to left commissure of the lip; line 5, right tragus to midline in chin; line 6, left tragus to midline in chin; line 7, right tragus to right ala; line 8, left tragus to left ala; and line 9, right gonion to left gonion<sup>9</sup>. Pain was subjectively assessed using a visual analogue scale (VAS) (Figure 1), a 10-point scale was used where 0 represented ‘no pain’ and 10 represented ‘worst possible pain’. The patients were asked to indicate the level of pain experienced by marking a 10-point scale. Oral hygiene status was assessed using simplified oral hygiene index (OHI-S) (Good=0.0-0.6; Fair= 1.3-3.0; Poor=3.1-6.0)<sup>10</sup>, four posterior and two anterior teeth were chosen; in total six tooth surfaces were examined and scored.

Occlusion was assessed using surgeon’s evaluation index<sup>11</sup>, where the following scores were subjectively given by the evaluator after assessing the subject’s occlusion: -5 points: occlusion altered bilaterally – Re-operation required; -3 points: occlusion altered on one side – Re-operation required; 1 point: occlusion altered on one side – Other side has to be adjusted; 3 points: occlusion adequate on both sides – But not the same as before injury; 5 points: occlusion the same as before. All these measurements were taken

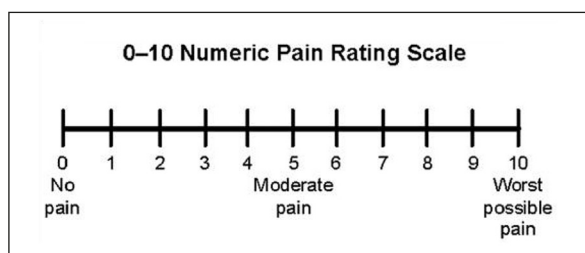


Figure 1. Visual Analogue Scale.

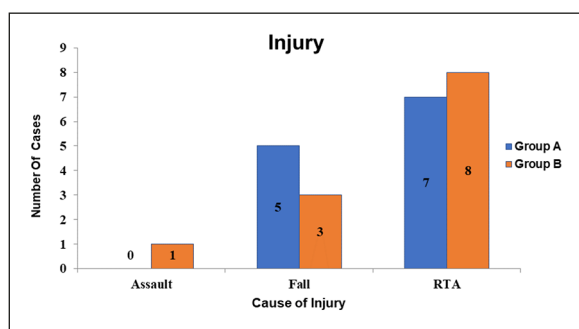


Figure 2. Cause of Injury (RTA – Road Traffic Accident).

post-operatively by the same evaluator on the 1<sup>st</sup>, 7<sup>th</sup> and 15<sup>th</sup> days.

### Statistical Analysis

At alpha 0.05, a power of 0.8, delta score of -5.0 VAS score, a total sample size of 24 was estimated (control group=12 and test group=12). The data obtained was tabulated and filled in Microsoft Office Excel spread sheet and SPSS software version 17 was used for statistical analysis. Inter- and intra-group comparison was done using parametric and non-parametric tests, as appropriate, i.e. Paired-*t* test, Chi-square test, Fisher’s exact test, and Bonferroni *t*-test.

### Results

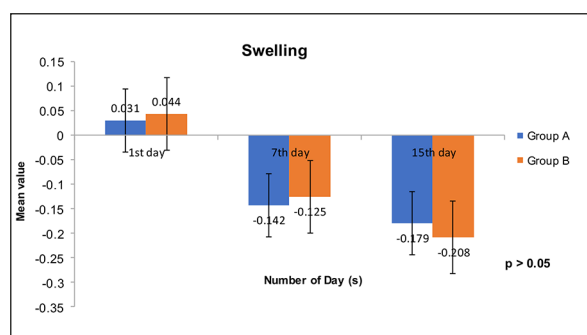
The study sample comprised 24 subjects between the age group of 18 to 65 years. The gender distribution of the subjects demonstrated a male predominance with 95.8% and 4.2% being females. It was found that nearly 62.5% of the cases were due to road traffic accidents (RTA), 33.3% of the cases were attributed to falls and 4.2% to assaults (Figure 2). There were no post-operative complications.

According to the results, the mean difference in gross swelling between the two groups on post-operative day (POD) 1 was 0.03± 0.06 for group-A and 0.04±0.04 for group-B. Following on POD 7 the value recorded was -0.14±0.08 and -0.12± 0.06 for group-A and group-B respectively. The mean difference of gross swelling on POD 15 was -0.17±0.09 and -0.20±0.12 for group-A and group-B respectively (Table I) (Figure 3). The reduction in oedema was found to be better in group A as compared to Group B. However, the mean difference between the groups was not significant (Table II).

**Table I.** Comparison of swelling postoperatively at different postoperative intervals.

POD	Group	N	Mean	Standard deviation	t-test value	p-value
1	Group A	12	0.031	0.06	0.530	0.602
	Group B	12	0.044	0.05		
7	Group A	12	-0.142	0.082	0.562	0.58
	Group B	12	-0.125	0.067		
15	Group A	12	-0.179	0.091	0.672	0.509
	Group B	12	-0.208	0.12		

POD: post-operative day.



**Figure 3.** Comparison of Swelling Postoperatively at different Postoperative intervals.

The mean pain VAS scale values obtained on POD 1 for group- A was  $6.62 \pm 2.13$  and for group-B was  $6.16 \pm 1.85$ . On POD 7 a marked reduction in pain was observed in group B as com-

pared to Group A, however this was statistically insignificant. Similarly, on 15h day the difference between the groups was not significant ( $p > 0.701$ ). A decrease in the value among three-time intervals was found to be statistically significant ( $p < 0.001$ ) (Table III) (Figure 4).

While comparing the mean values of simplified oral hygiene index (OHI-S) between the two groups the mean value on POD 1 for Group A was  $1.16 \pm 0.43$  and for Group B was  $1.10 \pm 0.49$ , this difference was not significant ( $p > 0.729$ ). But on POD 7 the mean for Group A and B was  $2.65 \pm 0.49$  and  $1.49 \pm 0.71$  respectively, the difference was found to be statistically significant ( $p < 0.001$ ). Similarly, on POD 15 when comparing the mean values of the two groups it was found to be highly statistically significant ( $p < 0.001$ ) (Table IV) (Figure 5). When the intragroup comparison of OHI-S was done it was

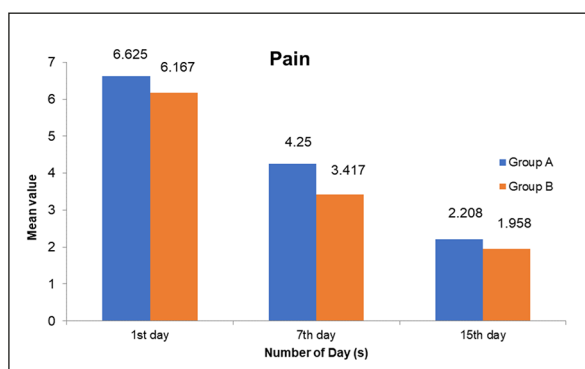
**Table II.** Intragroup comparison of postoperative swelling.

Group	(I) duration	(J) duration	Mean difference (I-J)	p-value
Group A	1 <sup>st</sup> day	7 <sup>th</sup> day	0.173	< 0.001
		15 <sup>th</sup> day	0.210	< 0.001
	7 <sup>th</sup> day	15 <sup>th</sup> day	0.037	0.794
Group B	1 <sup>st</sup> day	7 <sup>th</sup> day	0.168	< 0.001
		15 <sup>th</sup> day	0.252	< 0.001
	7 <sup>th</sup> day	15 <sup>th</sup> day	0.084	0.063

**Table III.** Comparison of postoperative pain at different time intervals.

POD	Group	N	Mean	Standard deviation	t-test value	p-value
1	Group A	12	6.625	2.13	0.562	0.58
	Group B	12	6.167	1.85		
7	Group A	12	4.250	2.38	0.947	0.354
	Group B	12	3.417	1.90		
15	Group A	12	2.208	1.88	0.389	0.701
	Group B	12	1.958	1.17		

POD: post-operative day.



**Figure 4.** Comparison of Pain Postoperatively at different Postoperative intervals

noted that increase in OHI-S score for group A was highly significant ( $p < 0.001$ ) whereas in group B the increase was very minor and not significant (Table V).

While scoring the occlusion at various post-operative intervals it was seen that on POD 1, 25% of Group A and Group B had score 1, but on 15<sup>th</sup> day 75% of Group A had a score of 5 and similarly that of Group B has only 50% of score 5. However, by applying chi-square test, the difference was not found to be significant (Table VI-VII) (Figure 6).

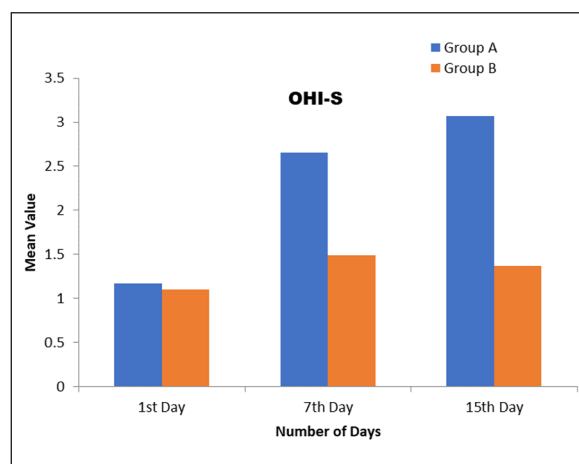
### Discussion

Management of fractures in the mandibular bone has been a dilemma faced by the maxillofacial surgeons through the ages. The view towards management of these fractures has been undergoing radical changes, yet there is no common consensus among the surgeons regarding the need for MMF post OR/IF. Champy et al (1978)<sup>7</sup> were the first to ascertain that fixation with mini-plates along the lines of osteo-synthesis on the mandible

was adequate to provide sufficient rigidity, so that MMF could be completely avoided.

In spite of all the evidence, in a questionnaire survey done by Shenoy et al<sup>6</sup> it was seen that majority of oral and maxillofacial surgeons still employ this almost obsolete modality postoperatively on a routine basis. It reflected on the fact that most surgeons consider occlusion to be the deciding factor when employing MMF and the use of post-operative MMF gives better occlusion as compared to ORIF alone. Currently, the use of this age-old practice still needs to be justified, in spite of presence of some studies that have opined regarding the futility of MMF post ORIF<sup>2,4</sup>.

In this study the aim was to assess if the post-operative use of MMF offered any benefits as compared to immediate mobilization following OR/IF of mandibular fractures. Subjects included in both groups received wide spectrum anti-microbial agents for a period of five days post-operatively and received a total of 16 mg of Dexamethasone, divided into two



**Figure 5.** Comparison of OHI-S Postoperatively at different Postoperative intervals.

**Table IV.** Comparison of OHI-S postoperatively at different postoperative intervals.

POD	Group	N	Mean	Standard deviation	t-test value	p-value
1	Group A	12	1.167	0.433	0.352	0.729
	Group B	12	1.100	0.494		
7	Group A	12	2.658	0.498	4.659	0.001
	Group B	12	1.492	0.710		
15	Group A	12	3.067	0.651	6.326	0.001
	Group B	12	1.367	0.665		

POD: post-operative day.



**Table V.** Comparison of intragroup OHI-S postoperatively.

POD	Group	N	Mean	Standard deviation	F-value	p-value
Group A	1	12	1.167	0.433	41.862	< 0.001
	7	12	2.658	0.498		
	15	12	3.067	0.651		
Group B	1	12	1.100	0.494	1.210	0.311
	7	12	1.492	0.710		
	15	12	1.367	0.665		

POD: post-operative day.

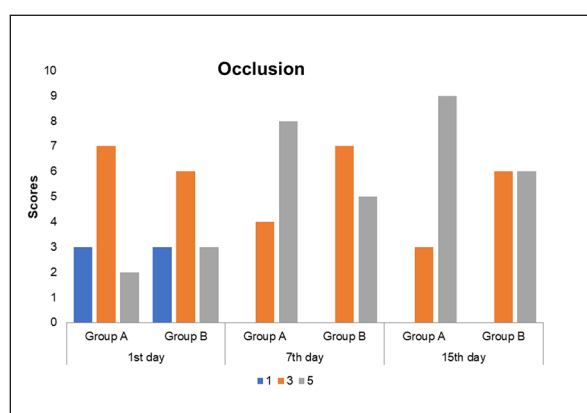
**Table VI.** Comparison of occlusion postoperatively at different postoperative intervals.

POD	1 <sup>st</sup> day		7 <sup>th</sup> day		15 <sup>th</sup> day		p-value
	Group A N	Group B N	Group A N	Group B N	Group A N	Group B N	
1	3	3	0	0	0	0	0.871
3	7	6	4	7	3	6	0.219
c5	2	3	8	5	9	6	0.206

POD: post-operative day.

**Table VII.** Comparison of intragroup occlusion postoperatively.

Group	Days	Post-operative day			Total N	p
		1 N	7 N	15 N		
Group A	1	3	0	0	3	< 0.001
	3	7	4	3	14	
	5	2	8	9	1	
Group B	1	3	0	0	3	0.063
	3	6	7	6	19	
	5	3	5	6	14	



**Figure 6.** Comparison of Occlusion Postoperatively at different Postoperative intervals.

doses post-operatively. In a study by Zahoor et al<sup>1</sup> mild swelling was noted in 76% of the patients in whom post-operative MMF was given, whereas severe swelling was seen in 16% of the patients in whom immediate mobilization was done postoperatively. A similar finding of reduction in swelling postoperatively in the MMF patients was also recorded by Schneider et al (2008)<sup>12</sup>. According to this report reduction in soft tissue swelling could be attributed to the reduced movements of the injured area resulting in reduced soft tissue oedema. This finding did not correlate with this present study as both study groups did not demonstrate any significant difference. The reason may be because the patients had movements in the

injured areas. Zahoor et al (2014)<sup>1</sup> used intravenous corticosteroid injection as per operative protocol to minimize swelling in both of the groups, while Schneider et al (2008)<sup>12</sup> did not mention the use of steroids.

In this work, the oral hygiene status of the patient was measured using the OHI-S, given by John C Greene and Vermillion (1964)<sup>10</sup>. The values were noted postoperatively on day 1, 7, and 15. When comparing the values, the difference was seen to be highly significant on POD 7 and POD 15, however it was not significant on POD 1. There was an increase noted in the score of OHI-S of Group A, which was statistically significant, thereby indicating a deterioration of the oral hygiene in patients with MMF. The same was not observed in Group B as the increase in value of OHI-S was slightly minor and was non-significant. In a study by Kaplan et al (2001)<sup>4</sup> not much of a difference was observed between the two groups while assessing the oral hygiene status.

In this study, the Occlusion of the subjects was assessed using a surgeon's evaluation index as proposed by Vedran Uglesic (1993)<sup>11</sup>. This index was chosen as it ensured the collection of a simple and reproducible data. By applying Kendals tau b test we tried to evaluate difference in the score from 1<sup>st</sup> day to 15<sup>th</sup> day. In group-A, 16.7% of people had a score of 5 and it reached 75% on 15<sup>th</sup> day. Here a significant difference was found in the increase of score ( $p < 0.001$ ). Thereby indicating improvement and stabilization of the occlusion. But in Group B on 1<sup>st</sup> day, it was 25% and on 15<sup>th</sup> day it reached 50%, however difference not significant ( $p > 0.063$ ). However, when comparing both the groups no significant difference was observed. Similar results were observed by Kaplan et al<sup>5</sup>. Similarly, in a study by Masoud Saman et al (2014)<sup>2</sup>, no significant difference was observed while assessing malocclusion in patients with and without postoperative MMF.

A review by Chrcanovic 2012 aimed to review the current practices and opinion on the management of comminuted mandible fractures (CMF's). Upon review of fifteen eligible articles, ORIF was indicated in severe displacement, edentulous and semi-dentate patients, mid-facial fractures. Minimally displaced fractures could be managed by closed reduction/conservative treatment. In terms of better technique, ORIF of CMF's can be better performed using load-bearing osteosynthesis<sup>16</sup>. Recently, significant

research on open vs. closed reduction have been published<sup>17-26</sup>. The inferences from these studies should be carefully assessed after internal and external validation. A meta-analysis on cost effectiveness was reported and surgical treatment found to be effective in patients above 16 years of age with low position of condylar fracture, severe displacement, dislocation and malocclusion<sup>27-29</sup>.

According to the results of this study, majority of the parameters observed did not show statistically significant difference between the two groups. It is also important to note that, postoperative MMF which is used by some of the surgeons as an assured way of obtaining a better occlusion, did not have statistically significant results<sup>13</sup>. No major difference was observed when examining swelling and pain between the two groups. The oral hygiene was seen to be better in patients with no MMF.

## Conclusions

From the present study after comparing the various postoperative parameters between the two groups no difference in swelling, or in pain was found. Oral hygiene was found to be worse MMF patient as compared to patients without MMF and there is no difference in the re-established occlusion postoperatively. Hence, these finding suggest that maintaining patients on MMF after ORIF of mandibular fractures does not offer any added benefits, when compared with immediate mobilization. Thus, the surgical dictum of postoperative MMF for all mandibular fractures is counter-productive. Further prospective, randomized study with a larger number of subjects spanning over a greater period of time would be useful in corroborating our results.

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### Conflict of Interest

The Authors declare that they have no conflict of interests.

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### Ethics Approval

The study was approved by Local Institutional Ethical Committee with the registration number ABSM/EC68/2015.

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### Authors' Contribution

S.S., N.S., S.K., G.C., A.R., G.B., M.R., M.P., M.D.F., C.M., and F.G. conceived and designed the analysis. All the authors contributed on analysis and interpretation of data for the work. All authors revised the work critically for intellectual content. Integrity of the work was appropriately investigated and resolved by all authors. All authors contributed and approved equally to the final version of the manuscript.

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