



## Navigating Furcation: A Guide for an Accurate Assessment

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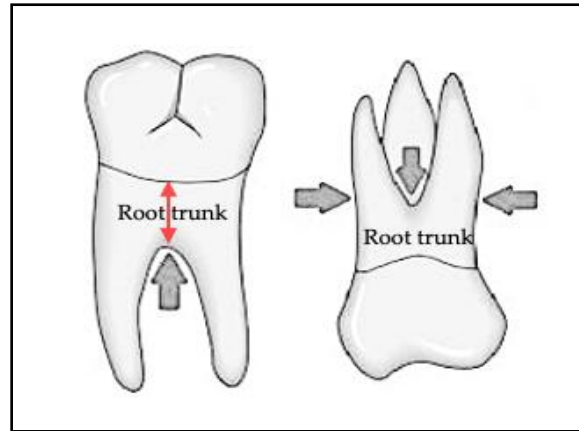


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### 1. Introduction

Furcations are found under the root trunk where roots of multirooted teeth converge (Figure 1). Furcation involvement is a significant concern in Periodontics. As previously reported<sup>1</sup>, probing the furcation area is challenging; attention to the tooth's anatomy is necessary to avoid errors in classifying furcation involvement as it refers to the clinical attachment loss (CAL)<sup>2</sup> between the roots, leading to a complex anatomical challenge for clinicians. Moreover, before measuring furcation involvement, it is recommended to remove debris and plaque to prevent them from interfering with the measurement. Studies indicate that molars with this clinical finding exhibit a higher risk of tooth loss than those without it, and the rates increase significantly with the severity of the involvement<sup>3,4</sup>. Some authors<sup>5</sup> reported that molars with Class II and III furcation involvement had approximately 3 to 7 times higher risk of progression of periodontitis and subsequent tooth loss. This highlights the critical need for accurate diagnosis and effective treatment strategies<sup>6-8</sup> tailored to the specific type of furcation involvement, as different furcation-defect classifications require distinct treatment approaches<sup>9</sup>. When the case involves class I furcation, it can usually be treated with non-surgical periodontal therapy (scaling and root planing, odontoplasty to reshape the roof of the furcation to eliminate areas that trap plaque, or furcation plasty); the goal of treatment is the bacteria removal

from the root surface and improve plaque control. Therefore, other considerations must be observed: the length of the tooth's root trunk affects treatment and prognosis, and teeth with shorter root trunks are easier to treat and maintain than teeth with longer root trunks.



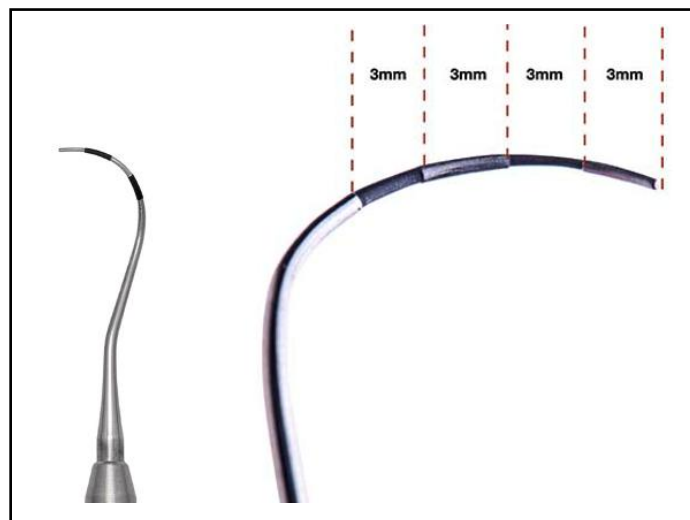
**Figure 1.** Molar anatomy. Gray arrows = furcation areas; red arrows = Root trunk.

The treatment of furcation defects often involves combining surgical and regenerative techniques to restore periodontal attachment and prevent further loss of interradicular bone. Various methods, such as guided tissue regeneration (GTR) and bone regeneration (GBR)<sup>10</sup>, have been employed to enhance healing and regeneration in these challenging areas. Recent systematic reviews have shown that regenerative therapies can yield predictable outcomes for Class II furcation defects, whereas Class III defects remain more challenging due to their complex anatomy and the difficulty of achieving adequate access for debridement and regeneration<sup>11</sup>. Moreover, adjunctive therapies, such as systemic antibiotics or locally delivered agents, have been explored to improve treatment outcomes, though their effectiveness can vary based on the individual case<sup>12</sup>. In order to optimize patient outcomes, managing a furcation involvement requires a comprehensive understanding of the underlying periodontal disease, careful treatment planning, and appropriate periodontal non-surgical and surgical therapy.

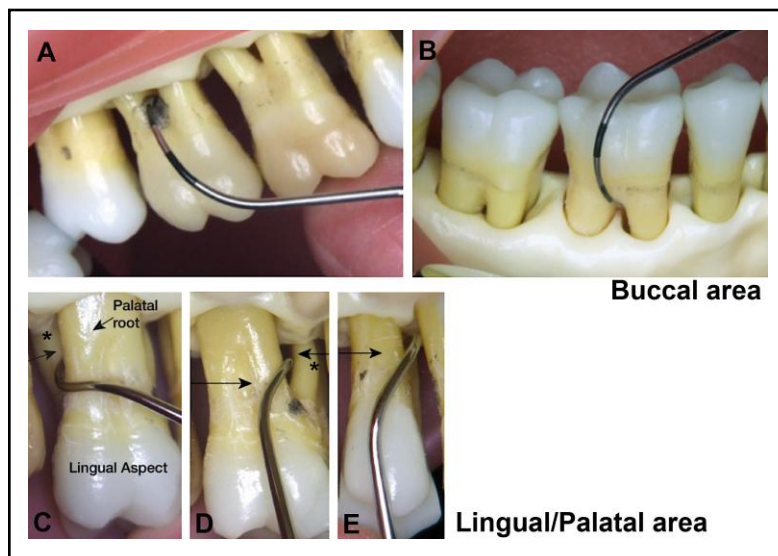
Hidden from view, furcation involvements may be overlooked during a comprehensive periodontal exam. A thorough and complete assessment may be challenging for many dental professionals, even when CAL is identified between the roots of teeth. In order to diagnose furcation involvement correctly and propose effective treatment options with optimal outcomes, a precise assessment technique must be implemented. In addition to furcation probes and periapical radiographs, computed tomography can be used, providing detailed three-dimensional images of the bone structure, resulting in a more precise diagnosis to evaluate the furcation involvement. This article provides a comprehensive review and a guide to strategies that will help the clinician navigate the complexities of furcation with higher confidence.

## 2. Furcation Assessment

Mandibular molars and maxillary first premolars are usually bifurcated, while maxillary molars are trifurcated (Figure 2). The number and the location of furcation inform the recommended approach to assessment. A furcation probe should be used to assess the extent of furcation involvement indicated by the amount of horizontal alveolar bone loss. Buccal furcation is evaluated from the buccal aspect of the mandibular and maxillary molars, while lingual and proximal furcation is explored from the lingual direction on all molars and maxillary first premolar (Figure 3). It is also possible to see the involvement of furcation by observing the radiographic images (Figure 4).

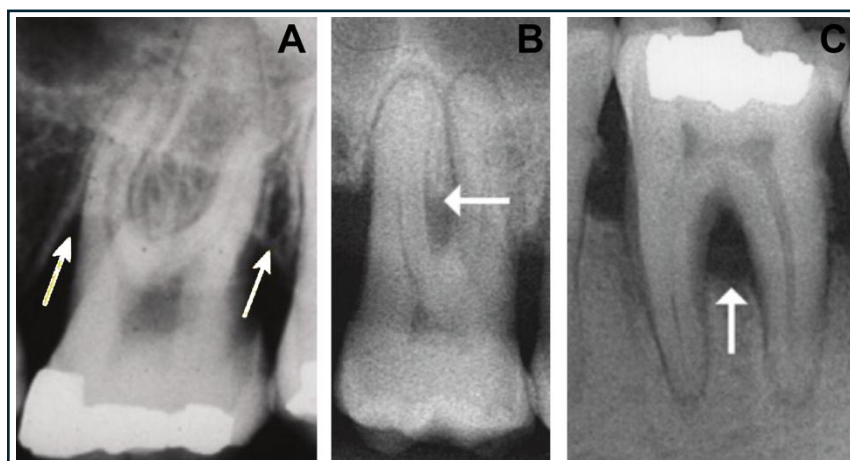


**Figure 2.** Furcation probe: Nabers. The most common Nabers type, ZA3 probe, has a diameter of 0.5 mm and graduations at 3, 6, 9, and 12 mm.



**Figure 3.** A. Probing buccal furcation of #3 from the buccal aspect. B. Probing buccal furcation of # 30 from the buccal aspect. C. Probing distal lingual of #3 from the lingual aspect (arrow\* = distobuccal root). D. Probing mesiolingual of

#3 from the lingual aspect (arrow = palatal root; arrow\* = mesiobuccal root); E. Probing mesial furcation of #5 from the lingual aspect (arrow showing palatal root).



**Figure 4.** The radiolucencies indicate furcation involvements (arrows). A. Furcation involvement on mesial and distal of the first upper left molar; B. Furcation involvement on buccal of the first upper right molar; C. Furcation involvement visible on a radiograph of the first lower left molar.

## 2.1 Step-by-Step Technique

1. Before using the furcation probe, determine the correct end on the selected surface. For buccal furcation on all molars and lingual furcation on mandibular molars, the terminal shank of the furcation probe should be parallel to the long axis of the tooth. On the other hand, the working end of the probe should wrap the tooth into the proximal furcation from the lingual aspect of maxillary molars and maxillary first premolar.
2. Place the probe into the suspected furcation area at the gingival margin.
3. Insert the probe beneath the margin and rotate the instrument's tip into the furcation.
4. Observe the horizontal extent of interradicular bone loss measured while accounting for the thickness of the gingiva.
5. If assessing vertical bone loss, use a periodontal probe to measure the periodontal pocket in the furcation area and determine the level of CAL in the furcation area.
6. Use the number of millimeters of bone loss (horizontally and vertically) to determine the furcation involvement grade that is based on our recommendation (main furcation classifications).

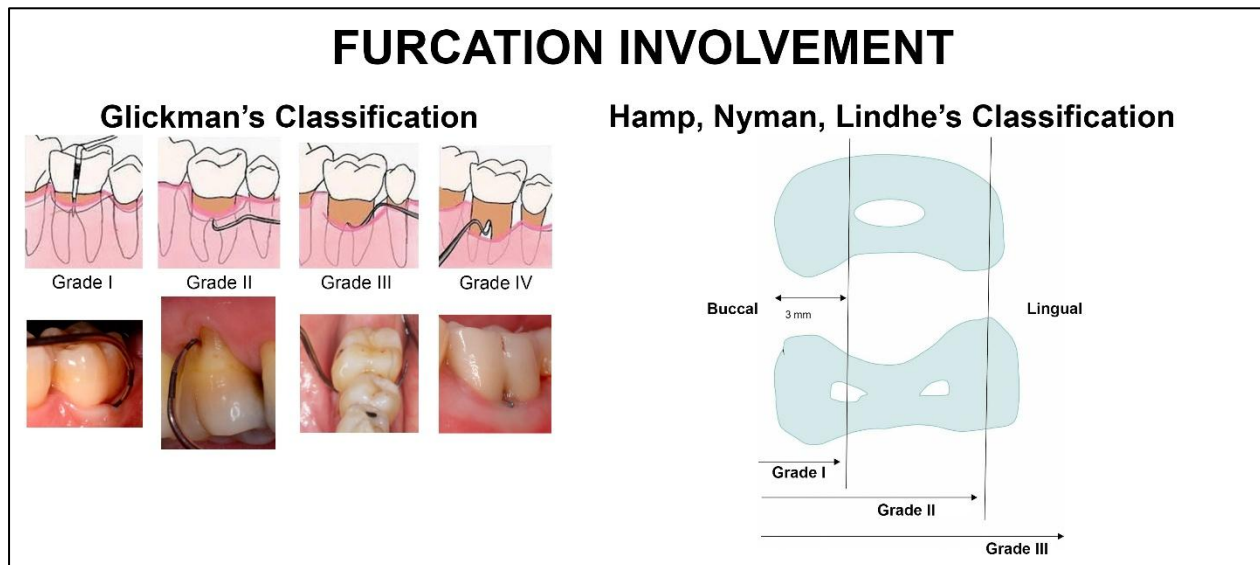
## 3. Main Furcation Classifications

This section describes two of the most common systems for classifications of furcation involvement at the horizontal level and one at the vertical level (Figure 5). The first is Glickman's classification<sup>13</sup>, which presents four different Grades of horizontal bone loss: **Grade I:** Furcation is felt with the probe, but the tip does not enter furcation more than 1mm; **Grade II:** Probe tip

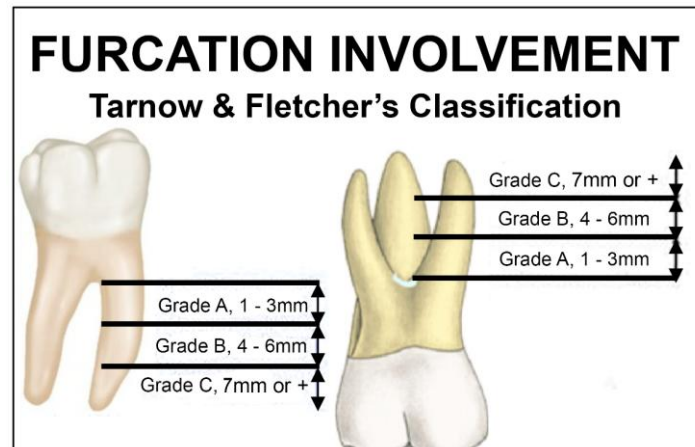
penetrates furcation more than 1 mm, extending to  $\frac{1}{3}$  of the buccal to lingual width, but does not go through to the other side completely; **Grade III**: Furcation is not visible clinically, but the probe completely passes between roots to the other side on mandibular molars and the maxillary first premolar (through-and-through). The probe passes between roots and touches the palatal root on the maxillary molars; and **Grade IV**: Same as grade III, except that furcation is clinically visible.

The second system considered the most commonly used for furcation assessment, examines interradicular bone loss is Hamp, Nyman, and Lindhe's classification<sup>14</sup>, which identifies three Grades of furcation involvement: **Grade I**: the probe penetrates horizontally into the furcation up to 3mm; **Grade II**: probe penetration into the furcation is more than 3mm but not through to the other side; and **Grade III**: penetration from one side to the other, through-and-through.

Tarnow and Fletcher presented another important classification for furcation that evaluates vertical bone loss<sup>15</sup>. It considered three grades: **Grade A**—vertical bone loss up to 3mm; **Grade B**—vertical bone loss between 4 and 6mm; and **Grade C**—vertical bone loss of 7mm or greater (Figure 6).



**Figure 5.** Horizontal assessment of Furcation involvement through the two most important classifications.



**Figure 6.** Vertical assessment of the furcation involvement: Tarnow & Fletcher's classification.

## 5. Other Furcation Classification

While we described three of the most commonly used classification systems for furcation involvement in detail, it is essential to include other classifications found in the literature.

1. **Goldman H.M.**<sup>16</sup>: **Grade I**: incipient lesion; **Grade II**: cul-de-sac lesion; **Grade III**: through-and-through lesion.
2. **Staffileno H.J.**<sup>17</sup>: **Class I**: furcation with a soft tissue lesion extending to furcal level but with minor degree of osseous destruction; **Class II**: furcation with a soft tissue lesion and variable degree of osseous destruction but not a through-and-through communication through the furcation; **Class II F**: furcation with osseous destruction from facial aspect only; **Class II L**: Furcations with osseous destruction from lingual aspect only; **Class II M**: furcation with osseous destruction from mesial aspect only; **Class II D**: furcation with osseous destruction from distal aspect only; **Class III**: furcation with osseous destruction with through-and-through communication.
3. **Easley J.R. et al.**<sup>18</sup>: **Class I**: incipient involvement, but there is no horizontal component to the furcation; **Class II: Type 1**. Horizontal attachment loss into the furcation, and **Type 2**. Vertical attachment loss into the furcation; **Class III**: through-and-through attachment loss into the furcation: **Type 1**. horizontal attachment loss into the furcation, and **Type 2**. vertical attachment loss into the furcation.
4. **Rosemberg M.M.**<sup>19</sup>: **Horizontal: Degree I**: probing < 4 mm; **Degree II**: probing > 4 mm. **Degree III**: two or three furcations classified as degree II are found. **Vertical: Shallow**: slight lateral extension of an interradicular defect, from the center of the trifurcation in a horizontal direction; and **Deep**: Internal furcation involvement but not penetrating the adjacent furcation.

5. **Ramjford S.P. et al.<sup>20</sup>**: **Class I**: tissue destruction < 2 mm (1/3 of tooth width) into the furcation; **Class II**: tissue destruction > 2 mm (>1/3 of tooth width); **Class III**: through-and-through involvement.
6. **Goldman H.M. et al.<sup>21</sup>**: **Degree I**: involves furcation entrance; **Degree II**: Involvement extends under furcation roof; **Degree III**: Through-and-through involvement.
7. **Richietti P.A.<sup>22</sup>**: **Class I**: 1 mm of horizontal invasion; **Class Ia**: 1–2 mm of horizontal invasion; **Class II**: 2–4 mm of horizontal invasion; **Class IIa**: 4–6 mm of horizontal invasion; **Class III**: >6 mm of horizontal invasion.
8. **Tal H. et al.<sup>23</sup>**: **Function involvement index (FII) scores**: **Furcal rating 1**: Depth of the furcation is 0 mm; **Furcal rating 2**: Depth of the furcation is 1–2 mm; **Furcal rating 3**: Depth of the furcation is 3 mm; **Furcal rating 4**: Depth of the furcation is 4 mm or more.
9. **Eskow R.N. et al.<sup>24</sup>**: **Furcation involvement is classified as Grade I subclasses A, B, and C (vertical involvement)**: **Subclass A**: vertical destruction > 1/3; **Subclass B**: vertical destruction of 2/3; **Subclass C**: vertical destruction beyond apical third of interradicular height.
10. **Fedi P.F.<sup>25</sup>**: **Glickman + Hamp classifications**: **Grades are the same as Glickman's classification (I–IV)**. **Grade II** is subdivided into **degrees I and II**: **Degree I**: vertical bone loss 1–3 mm; **Degree II**: vertical bone loss > 3 mm, but not communicate through-and-through.
11. **Grant D.A. et al.<sup>26</sup>**: **Class I**: involvement of the flute only; **Class II**: involvement partially under the roof; **Class III**: through-and-through loss.
12. **Basaraba N.<sup>27</sup>**: **Class I**: initial furcation involvement; **Class II**: partial furcation involvement; and **Class III**: communicating furcation involvement.
13. **Carnevale G. et al.<sup>28</sup>**: **Degree I**: Horizontal attachment loss < 1/3; **Degree II**: Horizontal attachment loss > 1/3; **Degree III**: horizontal through-and-through destruction.
14. **Hou G.L. et al.<sup>29</sup>**: **Classification based on root trunk length and horizontal and vertical bone loss**. **Types of root trunk**: **Type A**: furcation involving a cervical third of root length; **Type B**: furcation involving cervical third and cervical two-thirds of root length; **Type C**: furcation involving cervical two-thirds of root length.  
**Classes of furcation**: **Class I**: horizontal loss of 3 mm; **Class II**: horizontal loss > 3 mm; **Class III**: horizontal “through-and-through” loss.  
**Subclasses by radiographic assessment of the periapical view**: **Sub-class ‘a’**: suprabony defect; **Sub-class ‘b’**: infrabony defect.  
**Classification of furcation**: **AI, AII, AIII**. **Type A root trunks with class I, class II, and class III furcations**;  
**BI, BII, BIII**. **Type B root trunks with class I, class II, and class III furcations**;  
**CI, CII, CIII**. **Type C root trunks with class I, II, and III furcations**.
15. **Nevins M. et al.<sup>30</sup>**: **Class I**: incipient or early loss of attachment; **Class II**: a deeper invasion and loss of attachment that does not extend to a complete invasion; **Class III**: Complete



loss of periodontium extending from buccal to lingual surface. Diagnosed radiographically and clinically.

- 16. Glossary of periodontal terms:**<sup>31</sup> **Class I:** minimal but notable bone loss in furcation; **Class II:** Variable degree of bone destruction but not extending entirely through furcation; **Class III:** Bone resorption extending completely through furcation.

- 17. Walter C. et al.**<sup>32</sup>: **Modification of the Hamp et al. classification (degree II is divided into degrees II and II-III)**

**Degree I:** Horizontal attachment loss  $< 1/3$  of the width of the tooth;

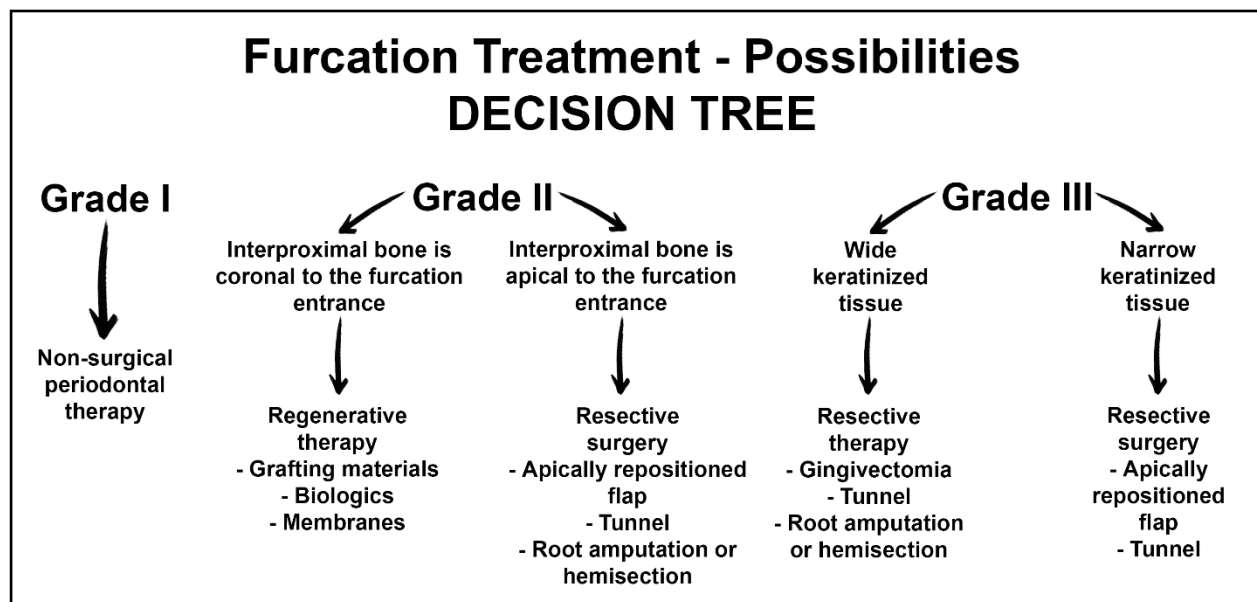
**Degree II:** Horizontal loss of support  $> 3$  mm,  $< 6$  mm;

**Degree II–III:** Horizontal loss of support  $> 6$  mm, but not extending completely through furcation;

**Degree III:** Horizontal through-and-through destruction.

## 6. Decision Tree Suggested for Furcation Treatment

Even though the focus of this article was not on treatment therapies for furcation, it is crucial to recognize the problem of furcation involvement and then select the best approach for treatment. More studies are suggested to better approach this part. Suggestions are presented below (Figure 7). For furcation grade I, it is recommended a non-surgical approach; for grade II, it is necessary to observe the interproximal bone level to have better options for treatment; and for grade III, it is recommended the analysis of the keratinized tissue.



**Figure 7.** Decision tree presentation for furcation treatment.



## 7. Conclusion

Assessing furcations on multirrooted teeth is an essential component of comprehensive periodontal assessment that must be performed on every dental patient. Accurate diagnosis of furcation involvement and timely intervention is not only the standard of care but is critical for achieving optimal clinical outcomes and restoring patients' periodontal health. However, facing many different classifications in the literature can cause problems of communication between professionals; thus, it is necessary to establish a standard language, keeping the most recognized classifications - (I) horizontal: Glickman's and Hamp, Nyman, and Lindhe's classification, and (II) vertical: Tarnow & Fletcher classification. Then, considering the focused material presented on furcation, which is the strength of this editorial, dental professionals can enhance their assessment skills and gain more confidence when diagnosing and treating furcations by utilizing the information and strategies outlined in this guide.

### Abbreviations

CAL	Clinical attachment loss
GTR	Guided tissue regeneration
GBR	Guided bone regeneration

### Declarations:

**Supplementary Materials:** Not applicable.

**Author Contributions:** Conceptualization, GVOF and RM; methodology, GVOF and RM; software, Ø; validation, GVOF and RM; formal analysis, GVOF and RM; investigation, GVOF and RM; resources, GVOF and RM; data curation, GVOF and RM; writing—original draft preparation, GVOF and RM; writing—review and editing, GVOF and RM; visualization, GVOF and RM; supervision, GVOF; project administration, GVOF; funding acquisition, Ø. All authors have read and agreed to the published version of the manuscript.”

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