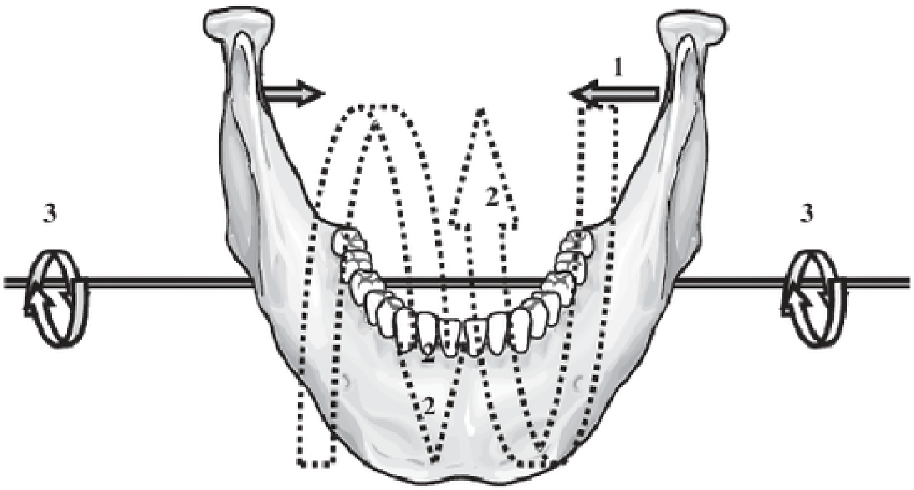
MANDIBULAR FLEXURE: A LITERATURE REVIEW

Alexandra Gannon[1]
[1]Imetric Research, Huntsville, AL



Abstract

The impact of mandibular flexure on digital implant position capture (i.e. differences in measurement values at a rest position compared to open) remains widely uninvestigated by the dental industry. This paper examined 13 different peer-reviewed articles across various publications including *The Journal of Prosthetic Dentistry, The Journal of Dentistry,* and *Journal of Oral and Maxillofacial Surgery,* among others, including two literature reviews which examined and compiled the findings of over 60 publications each.

Articles report a wide range of mandibular flexure and deformation among patients, with measured linear distortion values ranging from 30 to 1,000 micrometers (μm). Reported values include 30 μm (Regli et al.,1967), 114 μm (Fischman, 1990), 437 μm (Chen et al., 2000), and 870 μm (Londono et al., 2023), with values approaching 1,000 μm also documented (Choi et al., 2015). The variation in data acquisition and evaluation should be considered when assessing the clinical validity of mandibular deformation claims within these articles and could help explain the wide variation of values reported for mandibular flexure.

Additional research must be done using digital dentistry workflows to determine the extent of impact that mandibular flexure has on position-capture devices and their resulting restorations. Best practices for reducing the impact of mandibular flexure at the time of implant position capture include scanning as close to rest position as possible (less than 20 mm opening) and avoiding protrusion of the jaw.

Background

Mandibular flexure can be defined as “the mandibular deformation characterized by the property of the mandible to flex inward during opening and protrusion movements of the jaw with reduction in the width of mandibular arch” (Sivaraman et al., 2015). There are four patterns of jaw deformation proposed to occur instantaneously with jaw movement: Symphyseal bending or corporeal approximation, Dorsoventral shear, Corporeal rotation, and Anteroposterior sheer (Law et al., 2011).

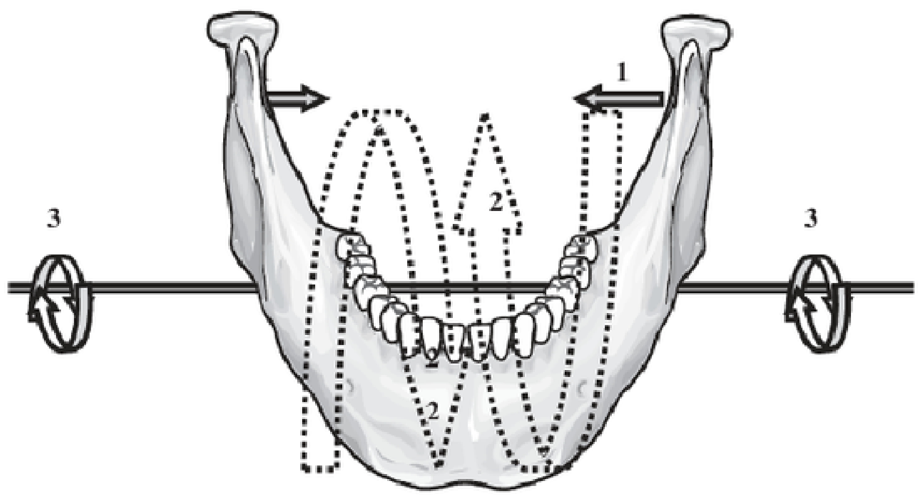


***Figure 1** – Image depicting different types of mandibular deformation: 1) Corporal approximation; 2) Corporal Rotation; 3) Dorsoventral shear. (Al-Sukhan et al., 2006).*

It has been suggested previously that differences in flexibilities between restorations and bone may result in issues such as bone loss, prosthetic screw loosening and/or fracture, and implant neck fracture (Bidez & Misch, 1992). Additionally, inhibition of mandibular flexure was shown to increase with the number of teeth splinted and as more rigid structures are used. (Aparna et al., 2011).

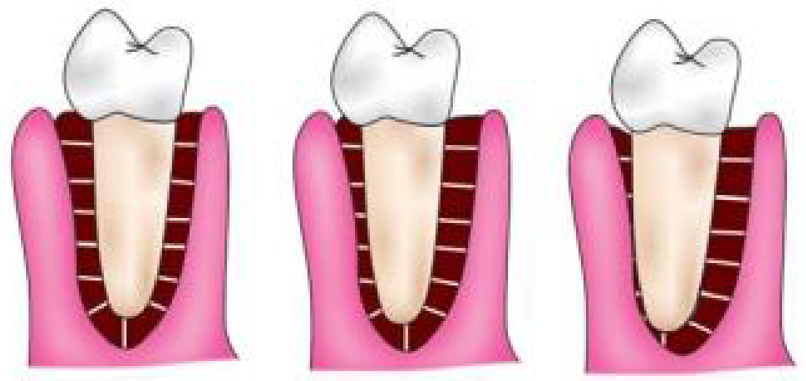


Figure 2 *– Illustration of periodontal attachment space: A) at rest, B) mandibular flexure not exceeding periodontal attachment space, C) splinted teeth resisting mandibular flexure which exceeds the periodontal attachment space (Aparna et al., 2011).*

Currently, most articles published related to the topic of mandibular flexure look to establish whether mandibular flexure is present, the extent to which the jaw narrows during flexure, and its overall impact on different fixed implant prosthesis. The impact of mandibular flexure on digital implant position capture (i.e. differences in measurement values at a rest position compared to open) remains widely uninvestigated by the dental industry.

Materials and Methodology

This paper examined 13 different peer-reviewed articles across various publications including *The Journal of Prosthetic Dentistry, The Journal of Prosthetic Dentistry*, and J*ournal of Oral and Maxillofacial Surgery*, among others, including two literature reviews which examined and compiled the findings of over 60 publications each. Relevant articles were identified using resource databases such as PubMed and the following search terms in different combinations: “Mandibular Flexure,” “Mandibular Deformation,” “Mandibular arch,” “Dental Implants,” and “Implants.” Articles that examined mandibular flexure’s impact on full-arch restorations were prioritized as well as those which looked at mandibular flexure as an independent, clinically relevant topic.

Results

Articles report a wide range of mandibular flexure and deformation as observed in different patients, finding measured linear distortion ranging between 30 μm (Regli et al., 1967), 114 μm (Fischman, 1990), 437 μm (Chen et al., 2000), 870 μm (Londono et al., 2023), with recognition of values up to 1000 μm (Choi et al., 2015). Corporal rotation and Dorsoventral shear were found to range between 0.4° and 2.8° in one of the articles (Al-Sukhun et al., 2006), and another study found 1-5° for Corporeal rotation and 3-14° Dorsoventral shear (Abdel-Latif et al., 2000).

While it is generally agreed upon that mandibular deformation occurs immediately upon any opening of the mouth (Al-Sukhun et al., 2006), previous research has shown a sharp increase in the magnitude of mandibular deformation when the mouth opens wider than 20 mm, relative to rest position, when measuring from maxillary incisal/occlusal edge to mandibular incisal/occlusal edge (tooth-to-tooth) (Gates et al., 1981). Similarly, another article which utilized cast impression and digital measurement found mandibular flexure to occur early in the opening cycle, with maximum changes occurring in as little as 12 mm of mandibular movement (Ioanid et al., 2017).

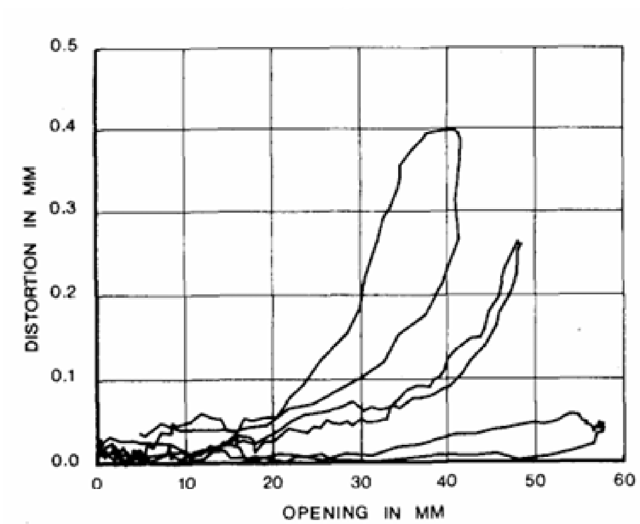


***Figure 3 –** Figure showing approximate linear distortion of the mandible for three different patients, highlighting the variability between patients and overall reduced deformation when opening is less than 20 mm (Gates et al., 1981).*

Discussion

It is noted that this review identified many different methods used for the measurement and evaluation of mandibular flexure including intraoral measurement using strain gauges and transducers and extraoral methods such as CBCT analysis and cast creations. Articles which used intraoral methods of data capture may have been limited by insertion of the measurement device into the mouth, potentially resulting inaccuracies within the “closed” jaw measurements.

Similarly, the resolution of measurement tools is varied, leading to difficulties in comparing findings between studies. The general variation in data acquisition and evaluation should be considered when assessing the clinical validity of mandibular deformation claims within these articles and could help explain the wide variation of values reported for mandibular flexure.

Conclusion

It can be concluded that mandibular flexure is a complex phenomenon which occurs in all patients with varying degrees of magnitude. It can also be concluded that these variations could cause issues for the success of fixed-implant restorations by reducing or resisting natural mandibular flexure and causing stress build-up around remaining teeth and decimation of the periodontal attachment space.

It is fair to assume that mandibular flexure may impact implant capture since mandibular flexure, particularly when the patient is opening wider than 20mm, could shift the location of implant positions. This could lead to additional stress as seen in the final restoration as the shifted locations will not match their rest-position counterparts.

Conclusion

Additional research must be done using digital dentistry workflows to determine the extent of the impact that mandibular flexure has on position-capture devices and their resulting restorations.

As suggested by several publications, best practices for reducing the impact of mandibular flexure at the time of implant position capture include scanning as close to rest position as possible (less than 20 mm opening) and avoiding protrusion of the jaw.

References

"Abdel-Latif, H. H., Hobkirk, J. A., & Kelleway, J. P. (2000). Functional mandibular deformation in edentulous subjects treated with dental implants. The International Journal of Prosthodontics, 13, 513–519.

Al-Sukhun, J., Helenius, M., Lindqvist, C., & Kelleway, J. (2006). Biomechanics of the mandible Part I: Measurement of mandibular functional deformation using custom-fabricated displacement transducers. Journal of Oral and Maxillofacial Surgery, 64, 1015–1022.

Aparna, I. N., Dhanaskar, B., Gupta, L., & Lingeshwar, D. (2011). Medial mandibular flexure: A review of concepts and consequences. International Journal of Oral Implantology and Clinical Research, 2, 67–71.

Bidez, M. W., & Misch, C. E. (1992). Issues in bone mechanics related to oral implants Implant Dentistry, 1, 289–294.

Chen, D. C., Lai, Y. L., Chi, L. Y., & Lee, S. Y. (2000). Contributing factors of mandibular deformation during mouth opening. Journal of Dentistry, 28, 583–588.

Choi, A. H., Conway, R. C., Taraschi, V., & Ben-Nissan, B. (2015). Biomechanics and functional distortion of the human mandible. Journal of Investigative and Clinical Dentistry, 6, 241–251."

Fischman, B. (1990). The rotational aspect of mandibular flexure. The Journal of Prosthetic Dentistry, 64, 483–485.

Gates, G., & Nicholls, J. (1981). Evaluation of mandibular arch width change. The Journal of Prosthetic Dentistry, 46, 385–392.

Ioanid, N., Tanculescu, O., Luca, O., Martu-Stefanache, M. A., Doscas, A. R., Ciofu, M., & Ifteni, G. (2017). Study on mandibular medial flexure value (MMF) for natural tooth and dental implant support. Romanian Journal of Oral Rehabilitation, 9, 99–108.

References

Law, C., Bennani, V., Lyons, K., & Swain, M. (2011). Mandibular flexure and its significance on implant fixed prostheses: A review. Journal of Prosthodontics, 21, 219–224.

Londono, J., Schoenbaum, T. R., Varilla Ortiz, A. V., Franco-Romero, G., Villalobos, V., Carosi, P., Mijiritsky, E., & Pozzi, A. (2023). Mandibular flexure and its significance: An in vivo cone beam-computed tomography proof-of-concept study. Journal of Clinical Medicine, 12, Article 4149.

Regli, C., & Kelly, E. (1967). The phenomenon of decreased mandibular arch width in opening movements. The Journal of Prosthetic Dentistry, 17, 49–53.

Sivaraman, K., Chopra, A., & Venkatesh, S. B. (2015). Clinical importance of median mandibular flexure in oral rehabilitation: A review. Journal of Rehabilitation, 43, 215–225.