Modified Self-centering Facebow: A Novel Prototype

Neha Lovekumar, Venugopal Vidyashree Nandini, Nikhath Sultana

ABSTRACT

Aim and objective: The purpose of this prototype model was to provide a novel and accessible facebow transfer.

Background: The practical application of this technique helps overcome the drawbacks of conventional facebow in providing accurate parallelism and precise midline orientation.

Technique: A MEMS-based three-axis gyroscope sensor is used for three axis rotational measurement. The electrical output of the gyroscope is via microcontroller that is driven to the OLED screen through I2C serial communication. A precise facial midline was obtained by using an adjustable laser module of 650 nm in the current developed system. This detachable assembly was mounted on the Hanau spring bow and was evaluated on two patients.

Conclusion: Incorporation of the Gyro sensor with the adjustable laser light indicator in Hanau spring bow achieved accurate orientation of the occlusal plane and also helps in precise midline positioning, thereby decreasing occlusal errors and increasing the precision of the facebow.

Keywords: Facebow, Gyroscope, Orientation.

INTRODUCTION

The facebow was introduced by George Snow (1899), with the objective of locating the rotational axis of the lower jaw. According to “The Glossary of Prosthodontic Terms,” a facebow is a caliper-like instrument that serves to record the spatial relationship of the maxillary dental arch to some anatomic reference point(s) and to transfer this relationship to an articulator. The main feature is that it helps in developing an occlusion that is compatible with the functional movement of the stomatognathic system. The occlusal plane position in the patient and the articulator is a link for achieving the functional and esthetic goals of treatment.

Spring bows cannot be used in wider articulators because of fatigue and manufacturers provide a transferring jig to ease the procedure. The relationship is transferred through a rod attached to the occlusal rim. The transferring rod is placed vertical relating to the head. When the spring bow is positioned horizontal, the transferring rod attains verticality. Verticality not maintained while tightening the clutches leads to change in the interrelationship between the rod and the occlusal rim when the transfer jig is attached to the articulator. In the clinical stage, there is no built verification provision to check the verticality of the transferring rod.

The present technique was intended to check horizontality by integrating the MEMS-based three-axis gyroscope sensor that was used for three-axis rotation measurement with a digital display. Gyro sensors are used to sense the orientation and rotational movement of a device. The electrical output of the gyroscope was given via a microcontroller driven to the OLED screen through I2C serial communication. The second feature incorporated into this design is precision in recording the facial midline. For this, a special feature to check for the alignment of the facial midline was incorporated using an adjustable laser module of 650 nm in the currently developed system. The wavelength of 540–690 nm does not penetrate into the skin and it is considered as a permissible range.

The aim of this novel prototype design was twofold, i.e., to incorporate a Gyro sensor with an adjustable laser light indicator in Hanau spring bow to achieve accurate orientation of the occlusal plane and in precise midline positioning.

Technique

After obtaining required consent and ethical clearance, this design of facebow was utilized for orientation relation during the fabrication of complete dentures. The patient was made to sit upright with head unsupported and bite fork attached to the maxillary occlusal rim (Fig. 1). The fork was attached to the transfer rod and the assembly to the facebow. The U-shaped frame was kept relating to the Frankfurt’s Horizontal plane. The Gyro sensor with an adjustable laser light indicator in the Hanau spring bow was used to achieve accurate orientation of the occlusal plane. The light indicator was adjusted until it coincided with the patient’s facial midline (Fig. 2). The clutches were tightened when the LED screen displayed perfect horizontality in all the three planes (Fig. 3). After tightening, the facebow was removed and the fork was secured on the transfer jig. The upper member of the articulator was then mounted with the maxillary cast.

The hardware of the prototype model consisted of a MEMS three-axis Gyroscope sensor* MPU6050 that provides data regarding rotation of the sensor in all three axes. The MEMS gyroscope is a chip-based technology. MEMS comprises of a suspended mass between a pair of capacitive plates. The...
provided data are transferred to the Arduino Nano by I2C serial communication. The microcontroller used in the Arduino Nano* is ATmega328 with a 16 MHz clock and 32 KB of flash memory enabled to compile the I2C, OLED, and MPU6050 library. This data were then processed to display it on an OLED screen* through I2C serial communication (Flowcharts 1 to 3).

A separate 5 mW laser module of 650 nm was used to align the midline of the face with the midline of the occlusal rim, where both laser module and microcontroller are given 9 volt power supply.

**Circuit Connections**

The circuit shown in Flowchart 3 depicts the MPU6050 and OLED display connections through Serial Clock (SCL)—pin: A4 and Serial Data (SDA)—pin: A5, respectively. These pins perform I2C communication for the microcontroller.

**Discussion**

The occlusal discrepancies are due to disparity between the patient’s rotational axis of the mandible and the arc of closure on an articulator. This affects the occlusal relationships of the dentures during function. The use of a facebow for dental reconstructive procedures is controversially discussed in the literature. However, opinions differ about the most appropriate method with regard to transferring the dental cast from the patient to the articulator and is debatable.
The current modification of design used in this prototype model provides a simple, time-saving method that is precise, ensuring progressive treatment outcomes for edentulous patients during prosthetic rehabilitation with complete dentures. This helps to achieve an accurate orientation of the occlusal plane and also provides precise midline positioning. Facebow transfer represents a small portion of chair side time in relation to correcting chair side occlusal errors. Since the horizontality is made digitally visible on the LED screen, it is a quantitative confirmation for the specialist when facebow transfer is performed, thereby reducing the errors that may be present when a conventional method is being followed. The Gyro sensor used was sensitive and even the slightest of motion could be recorded, which ensured superiority in comparison to the conventional method.

The adjustable laser light indicator used ensured the facial midline coincided with the marking made on the occlusal rims, thus reducing the errors of midline shift during denture fabrication. Any form of nasal deviations can also be located with the help of this model. Denture fabrication using this prototype model decreased patient discomfort as it avoids manual facial markings to locate the midline increasing the patient acceptance. In addition, the whole attachment was detachable and could be incorporated in any of the conventional facebows to provide better results. The facebow transfer thus performed on the patients using this novel device was time-saving, more reliable, precise, and cost-effective.

It could be concluded that there could be more modifications in the current prototype such as rechargeable battery with a battery-level indicator in display, proper casing, and reduction in the size of the apparatus. The prototype was tried on two patients and hence more clinical trials can be done to justify the results of the current study.

**Conclusion**

Incorporation of the Gyro sensor with adjustable laser light indicator in Hanau spring bow achieved accurate orientation of the occlusal plane and also helps in precise midline positioning, thereby decreasing occlusal errors and increasing the precision of the facebow.

**Acknowledgments**

I would like to thank Dr KA Sunitha, Dr N Deepa, Dr Abhisekh Behera for their sincere efforts and contribution.

**Trade Names**

- MEMS three-axis Gyroscope sensor (MPU6050, Prime Robotics, India)
- Arduino Nano (Prime Robotics, India)
- OLED screen (Generic, India)
REFERENCES

1. Glossary of prosthodontic terms, ninth edition. J Prosthet Dent 2017;117(5):1–105. DOI: 10.1016/j.prosdent.2016.12.001.

2. Ogawa T, Koyano K, Suetsugu T. The relationship between inclination of occlusal plane and jaw closing path. J Prosthet Dent 1996;76(6):576–580. DOI: 10.1016/S0022-3913(96)90432-1.

3. Ow RK, Djeng SK, Ho CK. Orientation of the plane of occlusion. J Prosthet Dent 1990;64(1):31–36. DOI: 10.1016/0022-3913(90)90149-7.

4. Kumar M, D’Souza D. Comparative evaluation of two techniques in achieving balanced occlusion in complete dentures. Med J Armed Forces India 2010;66(4):362–366. DOI: 10.1016/S0377-1237(10)80019-X.

5. Shetty S, Shenoy KK, Sabu A. Evaluation of accuracy of transfer of the maxillary occlusal cant of two articulators using two facebow/semi-adjustable articulator systems: an in vivo study. J Indian Prosthodont Soc 2016;16:248–252.

6. Chandrasekharan Nair K, Srividya S. Face bow transfer. TPDI 2012;3:44–46.

7. Sadhvi KV. Spirit level markers for face bow articulation. Kerala Dental Journal 2009;32(2):75–76.

8. Patil UA, Dhami LD. Overview of lasers. Indian J Plast Surg 2008;41(S1):S101–S113. DOI: 10.1055/s-0039-1700481.

9. Gámez J, Dib A, Espinosa IA. Facebows in the development of Michigan occlusal splints. Rev Fac Odontol Univ Antioq 2013;25:117–131.

10. Carlsson GE. Some dogmas related to prosthodontics, temporomandibular disorders and occlusion. Acta Odontol Scand 2010;68(6):313–322. DOI: 10.3109/00016357.2010.517412.

11. Farias-Neto A, Dias AH, de Miranda BF, et al. Face-bow transfer in prosthodontics: a systematic review of the literature. J Oral Rehabil 2013;40(9):686–692. DOI: 10.1111/joor.12081.

12. Hugger ATJ, Pröschel P, Strub JR, et al. The application of arbitrary face bow registration and transfer—what level of evidence exists? Dtsch Zahnärztl Z 2009;56(11):671–675.

13. Wilkerson DC. The need for face bows. J Am Dent Assoc 2016;147(9):696–697. DOI: 10.1016/j.adaj.2016.07.005.

14. Shah K, Koka S. Evidence-based practice and barriers to compliance: Face bow transfer. J Prosthodont Res 2016;60(1):20–22. DOI: 10.1016/j.jpor.2015.09.004.

15. Wang MQ, Xue F, Chen J, et al. Evaluation of the use of and attitudes towards a face–bow in complete denture fabrication: a pilot questionnaire investigation in Chinese prosthodontists. J Oral Rehabil 2008;35(9):677–681. DOI: 10.1111/j.1365-2842.2007.01835.x.

16. Ahlers MO, Edelhoff D, Jakstat HA. Reproduction accuracy of articulator mounting with an arbitrary face-bow vs. Average values—a controlled, randomized, blinded patient simulator study. Clin Oral Invest 2019(3):1007–1014. DOI: 10.1007/s00784-018-2499-6.

17. Maddula RT, Ariga P, Jain AR. Efficacy of the modified arbitrary facebow for recording the orientation jaw relation—a experimental study. Drug Invention Today 2018;10(9):1635–1640.