Utility of Facebow in the Fabrication of Complete Dentures, Occlusal Splints and Full Arch Fixed Dental Prostheses: A Systematic Review

Abstract

Objective: The objective of this study is to assess the utility of facebow transfer in the fabrication of occlusal splints, complete dentures and full arch fixed dental prosthesis.

Materials and Methods: A systematic review protocol was registered at PROSPERO registry, University of York, UK (CRD42016041919). Following databases were explored: PubMed, CINAHL, Cochrane, and Web of knowledge. The PICO model included participants who received occlusal splint or complete denture or full arch fixed dental prosthesis at the centric relation position. The intervention was the use of facebow transfer. Comparators were prosthesis made without using a facebow. Outcomes were the patient satisfaction of the prosthesis and the need for laboratory adjustments. Only randomized clinical trials were included in the present review. A customized data extraction pro forma was used to extract the data and assess its quality. Results: A total of 505 articles were retrieved. On excluding duplicates, protocols, case reports, case series, narrative reviews, etc., only eight studies were selected for review. Six clinical trials on 249 complete dentures and two clinical trials on 65 occlusal splints were reviewed. No study on full arch crown and bridge work satisfied the inclusion criteria. Conclusions: The use of facebow did not yield a superior fit or comfort of the complete dentures or occlusal splints. Therefore, there is no evidence of the utility facebow transfer for these prostheses. However, no inference could be drawn for its utility in full arch fixed dental prosthesis as there were no studies to draw an inference.

Keywords: Complete dentures, facebow, occlusal splints, prosthetics

Introduction

Facebow was first introduced by George Snow in 1899, with the intention of locating the rotation 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.[1] This procedure ensures that the cast of the maxillary dental arch is oriented at a similar or a comparable distance to the hinges of the articulator as in the natural maxillary teeth to the assumed “axis of rotation” of the temporomandibular joints. This record may then be used for fabrication of various prostheses such as complete dentures, occlusal splints, and full arch fixed crown and bridge work.

Among the procedures included in complete denture fabrication, those related to the recording of maxilla-mandibular relationship are probably associated with the most controversies. There is no evidence that a more complex fabrication technique including the use of facebow registration results in a better clinical outcome of complete denture treatment.[2] Almost all prosthodontic textbooks have continued to recommend the use of facebow records, and about 84% of dental schools in the USA still include it in their preclinical curriculum. However, among general dental practitioners, the utility of the facebow transfer has been questioned for long.[3] Considering the evolution of evidence-based dental practice, it becomes essential to identify (and eliminate) unnecessary diagnostic procedures and ineffective therapeutic interventions.[4] Interestingly, in Scandinavia, the use of facebow has been largely abandoned long ago, not only for complete denture fabrication but also in other types of prosthodontic work. The Scandinavian Society for Prosthetic Dentistry expressed that there is no published evidence showing that the use of...
a facebow will lead to better clinical end results than when not using it.\textsuperscript{[5]}

Facebow has been used in dentistry for nearly 120 years with various modifications, but no randomized controlled trial has ever substantiated its clinical benefits. Thus, its use in dentistry has largely been based on the clinicians preferences and individual judgment rather than true scientific evidence. We wanted to explore whether the use of facebow brings any benefit in prosthodontic patient for which we decided to conduct a systematic review with the following review question:

“Is there a difference between the fit and patient acceptance of prosthesis fabricated using classical technique (facebow transfer) versus a simplified technique (without a facebow transfer)?” The term prosthesis in the present review refers to complete dentures, occlusal splints, and full arch crown and bridge work.

Materials and Methods

Information sources

A systematic review protocol was registered at PROSPERO, an international prospective register of systematic reviews at University of York, UK with identifier # CRD42016041919. We searched following databases PubMed/Medline, CINAHL, Cochrane, and Web of Knowledge. The key terms used were: (“Facebow” or “Face‑bow” “Face bow” or “jaw relation” or “centric relation position”) AND (“Complete denture” or “Occlusal splint “or “full arch crown and bridge work” or “prosthetic rehabilitation”).

PICOS model

Our PICOS model includes patients receiving occlusal splints or complete dentures or full arch fixed prosthesis at the centric relation position. Intervention was the use of facebow transfer. Comparators were prosthesis made without facebow. Outcomes were patient acceptance of prosthesis and the need for laboratory adjustments. Study designs considered in the present systematic review were only the randomized clinical trials.

Inclusion and exclusion criteria

We included randomized clinical trials published from the year 1971 to 2017 in the English language in which comparison between complete dentures or occlusal splints or full arch crown and bridge work was done with or without a facebow transfer. The exclusion criteria included case reports, case series, narrative reviews, letters to editors, cohort studies, case–controls studies, single-arm longitudinal studies, and retrospective charts reviews or audits. A customized data extraction pro forma was used to extract the data and assess its quality.

Electronic search

The electronic search was independently done by two reviewers. Then on the basis of title, keywords and abstract, the studies were assessed for the relevance. Full text of the relevant papers that could not be classified was obtained. In cases of disagreement, a third reviewer was consulted to achieve a consensus. The reviewers were not blinded regarding the authors, journals, date of publication, or results. The risks of bias were assessed for the individual studies included in the review and as well as of the overall systematic review.

Results

The first electronic search yielded 505 titles. Once duplicates, studies not relevant to the research question, titles not in English and older than the year 1971 were excluded; only 278 titles were left. Seventy studies were further excluded whose abstracts were not available. After further exclusion of the irrelevant clinical trials, narrative reviews/guidelines, surveys and case reports, case series, etc., only 8 randomized controlled trials were finally considered suitable for the present systematic review [Figure 1]. These 8 studies had 249 complete dentures and 65 occlusal splints. No clinical trial on full arch fixed crown and bridge work satisfied the inclusion criteria [Table 1].

Discussion

Six clinical trials addressed the utility of facebow with a cumulative data of 249 complete dentures. Out of these studies, the largest contribution was from Kawai et al.\textsuperscript{[6]} Sixty-five occlusal splints were assessed in the other two clinical trials, with the larger contribution from Shodadai et al.\textsuperscript{[3]}
Nascimento et al.\(^\text{[5]}\) reported that a balanced occlusion can be achieved even without a facebow transfer. They reported that simplified approach (not using any facebow) could be an alternative approach of fabricating satisfactory complete dentures. They observed better patient satisfaction and greater number of occlusal contacts in centric relation and left lateral movement without using the facebow. However, a limited sample of five subjects studied using a crossover design and just 10 days of follow-up, made the generalizability of that study questionable.

Kawai et al.\(^\text{[6]}\) conducted a randomized clinical trial with 122 patients randomly allocated into two groups according to a classical (facebow) or a simplified technique (no facebow) for the construction of complete dentures. All dentures were constructed by two experienced prosthodontists. Patients’ ratings on a visual analog scale (VAS) for overall satisfaction, comfort, stability, esthetics, ability to speak, ease of cleaning, and ability to chew food were done at 3 and 6 months of prosthesis insertion. The quality of the dentures was also assessed. No significant difference in the patient satisfaction or the perceived quality of conventional dentures produced with classical or simplified techniques was found. Regression analysis revealed no effect of potential confounders (age, gender, edentulous period, and treating prosthodontist) over the prosthesis satisfaction.

Furthermore, Kawai et al. used their previous data\(^\text{[6]}\) and compared the laboratory cost and clinician’s labor time between the two methods.\(^\text{[7]}\) The simplified technique decreased laboratory cost and clinician’s time. However, this reduction was influenced by both the single impression and the maxilla-mandibular recording. Their conclusion was that the quality of complete dentures does not suffer when manufacturing techniques were simplified to save time and materials.\(^\text{[7]}\)

Heydecke et al.\(^\text{[8,9]}\) conducted two trials, using the same set of data, to evaluate the influence of facebow transfer and occlusal concept on general satisfaction, comfort, ability to speak, stability, esthetics, ease of cleaning, and ability to chew. Twenty subjects wore two sets of complete dentures for equal periods of 3 months. One set was constructed using a facebow and teeth arranged in balanced occlusion. The other set was made using a simplified method without facebow transfer and canine/first premolar guidance. VAS measures for general satisfaction, stability, and esthetics were significantly better for the simplified method. No difference was found for the ability to speak, comfort, ability to chew, and the ease of cleaning the dentures.\(^\text{[8]}\) Furthermore, chewing ability was rated more favorably with the simplified method.\(^\text{[9]}\) At the end of the study, patients were asked to choose one set of dentures. Five subjects preferred the classical method, 12 preferred the simplified method and three patients had no preference.\(^\text{[8]}\)

Cunha et al.\(^\text{[10]}\) adopted the same protocol as Kawai et al.\(^\text{[6]}\) in a randomized clinical trial on 42 subjects. They reported that the simplified method for complete denture fabrication is able to restore masticatory function to a level comparable to that of classical method. Thus, no superiority of the facebow transfer was demonstrated.

Omar et al.\(^\text{[11]}\) studied forty-three edentulous patients and randomly assigned them to one of the four groups according to selected variations of the laboratory steps: Group 1 (n = 10), omission of secondary casts obtained from impressions in the border molded custom trays;
Group 2 \((n = 10)\), omission of secondary casts and facebow articulator mounting; Group 3 \((n = 10)\), omission of facebow mounting; and Group 4 \((n = 13)\), no steps omitted (control). Other clinical procedures for all groups were identical and performed by senior dental students under the supervision of prosthodontists, all of whom were blinded to the group allocation. At 1-, 4-, and 12-week of denture insertion, patients rated their overall satisfaction, as well as a range of functional factors using VAS. An independent-blinded prosthodontist rated four domains of denture quality. They concluded that selected omissions of steps (facebow mounting and/or secondary casts) in complete denture fabrication had only a minor role, if at all in the outcome. Thus, advocated that dentures be constructed without the facebow to save time and money.

Kumar and D’Souza\(^{[12]}\) in a clinical trial, evaluated two techniques, one with facebow and the other without facebow, to assess the reduction in treatment time while retaining the quality of complete dentures fabrication. Twenty edentulous subjects were selected, and each participant received two pairs of complete dentures. Dentures were made from duplicated casts and each one followed different techniques (facebow versus no facebow). The number of occlusal contacts in centric relation and excursive movements was registered. Both sets of dentures had a balanced occlusion. The feedback from the patients regarding the dentures was obtained. Simplified technique (no facebow) offered favorable results regarding time consumed, esthetics, comfort, and stability.

To summarize, out of six studies regarding the complete denture fabrication, following four studies: Heydecke\(^{[3]}\), Cunha et al.\(^{[9]}\), Omar et al.\(^{[11]}\) and Kawai et al.\(^{[6]}\) showed that there is no difference between the simplified and classical approaches for patient outcomes, whereas two studies: Nascimento et al.\(^{[5]}\) and Kumar and D’Souza\(^{[12]}\) demonstrated better results for the simplified approach. This provides evidence that avoiding the facebow transfer in complete denture fabrication would not result in any inferior outcomes in the complete denture fabrication.

However, all the studies included in the present systematic review had one thing in common, the complete dentures were either made by the specialist prosthodontists or postgraduate residents or trained dental technicians but whether undergraduate students may achieve similar clinical outcomes for complete dentures or occlusal splint remains unanswered. This makes dental educators wonder whether to shorten the time devoted for the teaching of facebow transfer and enhance the practice of more critical procedures. More studies are needed to evaluate outcome of prosthesis made with simplified method by the undergraduate students.

Two studies investigated the use of the facebow in occlusal splints. Shodadai et al.\(^{[3]}\) evaluated the influence of facebow transfer on the number of intraoral occlusal contacts and the time needed for chairside occlusal adjustment of the occlusal splints in a randomized clinical trial. The sample consisted of 20 fully dentate adult patients diagnosed with bruxism. For each patient, two acrylic resin occlusal splints were constructed successively by the same experienced dental technician using the same articulator. One of the occlusal splints was constructed using a facebow transfer, while the other occlusal splint was constructed by arbitrarily mounting the maxillary cast. The two splints were inserted and adjusted in a random order. Clinical outcomes did not differ between the two occlusal splints. The authors suggested a combination of factors to explain why patients may not benefit from facebow transfer: change (usually increase) of the occlusal vertical dimension after making the centric relation record; lack of evidence for pure condylar rotation and the existence of a condylar hinge axis on mandibular opening; unpredictable and variable condylar movements on mandibular opening; use of rigid hinge axis articulators; and the presence of temporomandibular pain.

Gámez et al.\(^{[13]}\) conducted a trial to compare the mounting time and number of occlusal contact points in Michigan occlusal splints made with or without facebow transfer in bruxism patients. A total of 90 splints were made and distributed among 45 bruxer patients. The occlusal contact points over the two types of splints were similar \((P = 0.79)\). Mounting time was also similar for the two techniques \((P = 0.33)\). It was concluded that there were no significant differences in the splints made for bruxers using classical or simplified technique.

A recently published review showed that the use of facebow is redundant and also questioned the dental schools which still endorse its use.\(^{[2]}\) However, a number of investigators have raised concern over the scientific conduct of that report.\(^{[14,15]}\) Proponents of the facebow transfer believe that it should be retained in the dental practice as they understand that a correct arc of closure is absolutely dependent on a correct condylar axis position and this is essential in maintaining the centric relation position. On the other hand, the scientific evidence shows that the opposite is true. It appears that the dentists, who believe that facebow registration is essential, should continue using it but they should not insist that it is a scientifically based method.\(^{[14]}\)

An interesting finding related to the facebow is that despite the fact there is no compelling evidence supporting the use of the facebow transfer with regard to improving patient outcomes, the teaching of the facebow transfer in the US-based dental schools has increased. From prevalence, 84% reported in 2005,\(^{[17]}\) the prevalence of facebow teaching became 93.75% in 2015.\(^{[18]}\) This continued unjustified teaching of the facebow transfer showed that prosthodontic curriculum is not compliant with evidence-based dental practice.
A recently published randomized clinical trial\(^{[19]}\) has also demonstrated that there is no substantial difference by the use of the arbitrary facebow compared to a mean setting when changing the vertical dimension in the articulator for a remount procedure of complete dentures. This trial was not part of the present review as the outcome was different.

While assessing the risk of bias of the individual studies [Figure 2], it can be appraised that out of 8 studies; only four had relatively good quality, as they paid detailed attention to the elements of good clinical trial. Two studies were just acceptable while the remaining two were poorly conducted. Figure 3 shows the overall risk of bias of the included studies, and it can be seen that the neglected elements in these studies were random sequence allocation and allocation concealment and lack of information regarding blinded outcome assessor. Thus, the quality of included trials was not too impressive.

### Conclusions

The number of randomized clinical trials on the utility of facebow transfer was limited \((n = 8)\). The data of complete dentures \((n = 249)\) and occlusal splints \((n = 65)\) suggest that facebow transfer does not yield a superior prosthesis (complete denture or occlusal splint). There are no clinical trials available for the utility of facebow transfer in full arch crown and bridge work. Thus, no inference can be drawn for fixed prosthodontics work.
Recommendations

In the present review, the facebow fails to demonstrate its utility in the fabrication of complete dentures and occlusal splints. Thus, there is no evidence to continue its use in the dental practice and teaching. However, there are no data regarding its utility in full arch fixed prosthodontic work for which good quality clinical trials are needed.

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Conflicts of interest

There are no conflicts of interest.

References

1. The glossary of prosthodontic terms. J Prosthet Dent 1999;81:39-110.
2. Yohn K. The face bow is irrelevant for making prostheses and planning orthognathic surgery. J Am Dent Assoc 2016;147:421-6.
3. Shodadai SP, Türp JC, Gerds T, Strub JR. Is there a benefit of using an arbitrary facebow for the fabrication of a stabilization appliance? Int J Prosthodont 2001;14:517-22.
4. Carlsson GE. Facts and fallacies: An evidence base for complete dentures. Dent Update 2006;33:134-6, 138-40, 142.
5. Nascimento DF, Patto RB, Marchini L, da Cunha VP. Double-blind study for evaluation of complete dentures made by two techniques with and without facebow. Braz J Oral Sci 2004;3:439-45.
6. Kawai Y, Murakami H, Shariati B, Klemetti E, Blomfield JV, Billette L, et al. Do traditional techniques produce better conventional complete dentures than simplified techniques? J Dent 2005;33:659-68.
7. Kawai Y, Murakami H, Takanashi Y, Lund JP, Feine JS. Efficient resource use in simplified complete denture fabrication. J Prosthodont 2010;19:512-6.
8. Heydecke G, Akkad AS, Wolkewitz M, Vogeler M, Türp JC, Strub JR, et al. Patient ratings of chewing ability from a randomised crossover trial: Lingualised vs. First premolar/canine-guided occlusion for complete dentures. Gerodontology 2007;24:77-86.
9. Heydecke G, Vogeler M, Wolkewitz M, Türp JC, Strub JR. Simplified versus comprehensive fabrication of complete dentures: Patient ratings of denture satisfaction from a randomised crossover trial. Quintessence Int 2008;39:107-16.
10. Cunha TR, Della Vecchia MP, Regis RR, Ribeiro AB, Muglia VA, Mestriner W Jr., et al. A randomised trial on simplified and conventional methods for complete denture fabrication: Masticatory performance and ability. J Dent 2013;41:133-42.
11. Omar R, Al-Tarakemah Y, Akbar J, Al-Awadhi S, Behbehani Y, Lamontagne P, et al. Influence of procedural variations during the laboratory phase of complete denture fabrication on patient satisfaction and denture quality. J Dent 2013;41:852-60.
12. Kumar M, D’Souza D. Comparative evaluation of two techniques in achieving balanced occlusion in complete dentures. Med J Armed Forces India 2010;66:362-6.
13. Gámez J, Dib A, Espinosa IA. Facebows in the development of Michigan occlusal splints. Rev Fac Odontol Univ Antioq 2013;25:117-31.
14. Wilkerson DC. The need for face bows. J Am Dent Assoc 2016;147:696-7.
15. Khanna N. More on face bows. J Am Dent Assoc 2016;147:697-8.
16. Yohn K. Author’s response. J Am Dent Assoc 2016;147:698-9.
17. Petropoulos VC, Rashedi B. Complete denture education in U.S. Dental schools. J Prosthodont 2005;14:191-7.
18. Shah K, Koka S. Evidence-based practice and barriers to compliance: Face bow transfer. J Prosthodont Res 2016;60:20-2.
19. von Stein-Lausnitz M, Sterzenbach G, Helm I, Zorn A, Blankenstein FH, Ruge S, et al. Does a face-bow lead to better occlusion in complete dentures? A randomized controlled trial: Part I. Clin Oral Investig 2017; DOI 10.1007/s00784-017-2152-9.
20. Farias-Neto A, Dias AH, de Miranda BF, de Oliveira AR. Face-bow transfer in prosthodontics: A systematic review of the literature. J Oral Rehabil 2013;40:686-92.