Review

Utility versus futility of facebow in the fabrication of complete dentures: A systematic review

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Abstract

Aim: The aim of this review was to investigate utility or futility of facebow for fabrication of complete denture prosthesis to maximise clinical efficiency and acceptability of complete dentures.

Settings and Design: Systematic review following PRISMA guidelines.

Materials and Methods: A study question was designed based on PICOT model which was used to evaluate whether facebow transfer is required or not for fabrication of complete denture prosthesis. An extensive search was carried out manually and using electronic databases such as PubMed-Medline, Cochrane, Google Scholar, and Clinicaltrials.gov. Parameters under review included patient satisfaction, masticatory efficiency, occlusal adjustments, clinician time, stability and retention. Boolean operators, MeSH terms and limiters were applied to develop the search and reach to conclusive studies pertaining to study design. Literature dated between 1950 and 2019 were selected. The data extraction and assessment of the studies was done by two independent investigators.

Statistical Analysis Used: No meta-analysis was conducted due to heterogeneity of data obtained.

Results: 13690 studies were shortlisted, 13672 were excluded based on title and abstract. By the end of search phase, 07 RCTs were considered relevant. 04 studies concluded comparable/ no differences in outcome with and without use of facebow for fabrication of complete denture prostheses, whereas 03 studies concluded better results without the use of facebow.

Conclusion: The use of facebow results in fabrication of complete denture prostheses with similar results in terms of clinical efficiency and patient acceptability as compared to simplified techniques using anatomical landmarks. Variations in assessment criteria, non uniform distribution of sample size amongst different clinical trials and subjective questionnaire based criteria are the weaker links in the review. Extensive research and long term standardised studies with objective criteria for assessment are required for comprehensive and conclusive results to establish the need for change in clinical practice.

Keywords: Complete dentures, facebow, randomized clinical trial

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INTRODUCTION

In the present era, due to advancements in health-care facilities, the average life expectancy of humans has improved. The overall prevalence of edentulism was 11.7% in six countries, with India, Mexico, and Russia having higher prevalence rates (16.3%–21.7%) than China, Ghana, and South Africa.[1] Fabrication of complete dentures has been used as a standardized protocol for rehabilitation of complete edentulism with the aim to improve form, function, and esthetics, thereby improving the quality of life of the geriatric population. Complete denture fabrication is a staged approach which involves multiple steps such as diagnosis and treatment planning, impression making, border molding, recording maxillo-mandibular relations, selection of artificial teeth, and denture processing and insertion.

The primary objective of complete denture prosthesis fabrication is to achieve harmonious occlusion with that of stomatognathic system. To record the correct relationship of mandible to maxilla and cranium, recording orientation jaw relation is of great value. Orientation jaw relation helps in the orientation of mandible to cranium in such a way that when mandible is kept in its most posterior position, it can rotate in sagittal plane around the imaginary transverse axis passing through or near the condyles.[2] There are different school of thoughts regarding the location of transverse hinge axis.[3]

The California Gnathologic Society first described the actual kinematic location of hinge axis under the leadership of McCollum. The instrument used to locate the transverse axis of rotation was named as facebow.

Facebow is an instrument used to record the spatial relationship of the maxillary arch to some anatomic reference point or points and then transfer it to the articulator; it orients the dental cast in the same relationship to the opening axis of the articulator; customarily, the anatomic references are the mandibular transverse horizontal axis and one of the anterior reference points.[4]

A.D. Gritman introduced the term facebow with the statement "Implement devised by Prof Snow as bow of metal (that) reaches around the face."[5]

Lazzari described various advantages of using facebows that it permits a more accurate use of lateral rotational points for arrangement of teeth and it aids in securing the anteroposterior positioning of the cast in relation to the condyles.[6] Various new designs of facebow have evolved with time, and manufacturers are still presenting variable designs. All the books and articles being published are describing the use of facebow for the fabrication of various dental prostheses. In about 75% of dental schools in the USA, use of facebow is a part of teaching curriculum.[7] However, it has not been clinically proven or there is no scientific evidence that facebow transfer is indispensable to achieve better clinical results.

As the application of facebow still remains questionable, the purpose of this review is to investigate the utility of facebow transfer for complete denture fabrication to improve patient acceptability.

MATERIALS AND METHODS

Information source/search strategy

This systematic review has been submitted for registration on PROSPERO vide reference no. 162484.

An extensive search was carried out manually and using electronic databases such as PubMed-Medline, Cochrane, Google Scholar, and Clinicaltrials.gov. The key terms searched were complete dentures and facebow with patient satisfaction, masticatory efficiency, occlusal adjustment, clinician time, stability, and retention by applying Boolean operators. Additional references from citations within the articles were obtained, and textbooks were also searched. Literature dated between 1950 and 2019 were selected.

MeSH terms used were ("complete dentures") AND "facebow") AND "patient satisfaction") AND masticatory efficiency") AND occlusal adjustment") AND "clinician time") AND stability) AND retention) NOT "fixed dentures."

Limiters were applied in the form of clinical trials, human studies, and publication date to develop the search.

The PICOT model was followed to formulate the research question:

- P: Edentulous patients receiving complete denture prosthesis will form the population under study
- I: Complete dentures fabricated using facebow will be determined as intervention
- C: Complete denture prosthesis without using facebow will serve as the control
- O: Patient satisfaction, masticatory efficiency, occlusal adjustment, clinician time, stability, and retention were measured after complete dentures were delivered
- T: Randomized clinical trials published from the years 1950 to 2019 in the English language in which comparison between complete dentures fabricated with and without the use of facebow was performed were included.

Study design

Study designs considered in the present systematic review were only the randomized clinical trials.

Objectives

The objective is to evaluate the utility of facebow transfer for complete denture fabrication to improve patient acceptability.

Inclusion and exclusion criteria

All randomized clinical trials:

1. Comparing complete denture fabrication with or without the use of facebow in patients of any age
2. Sample size of at least five patients
3. Evaluating patient satisfaction, clinician time, stability, and retention were included in the systematic review.

All case reports/series, reviews, cohort studies, cross-sectional studies, or *in vitro* studies were excluded.

Review method

All reports were identified taking various keywords and MeSH terms into consideration. The search was not biased toward author name, journal, date of publication, and with or without financial support. All the relevant articles were printed and analyzed by two reviewers. All the articles that could not be classified were also obtained. A third reviewer was consulted to analyze and arrive at a consensus. The reviewers were not blinded as to title, keywords, and abstract to check the relevance.

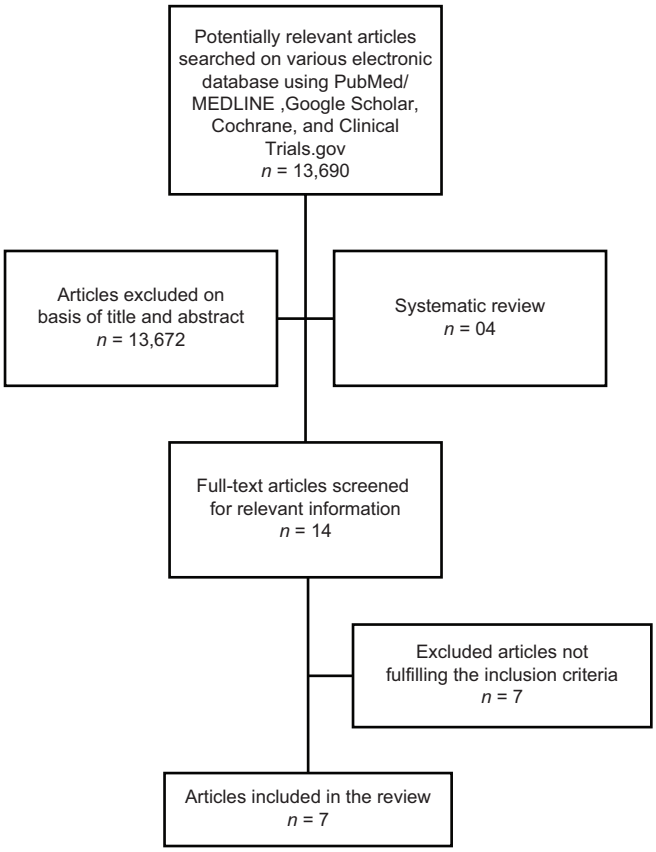

Figure 1: Studies assessed and excluded at various stages of review

RESULTS

The search led to identification of 13,690 articles on various databases when searched using key terms [Figure 1]. Out of the 13,690 articles obtained, 13,672 were excluded based on the title and abstract as they did not evaluate the parameters under review. Four studies were eliminated as these were published systematic review on same parameters. The search for full text identified 14 studies, out of which 7 studies were excluded as they did not fit into the inclusion criteria for the comparison of complete denture fabricated by simplified and traditional techniques for the assessment of desired parameters. The remaining seven randomized clinical trials evaluating the desired parameters under review were selected for systematic review [Table 1]. Out of these seven Randomized clinical trial (RCTs), four trials showed no difference or comparable efficiency in terms of one or few parameters, while three studies showed that techniques without using facebow showed better clinical outcome.

DISCUSSION

A survey of 43 US dental schools conducted by Petropolus and Rashedi revealed that facebow was taught as a part of clinical (2001) and preclinical (2005) curriculum in 84% of the schools.[8] Shah and Koka (2016) reported the prevalence of facebow teaching to be 93.75%.[9] Although all the surveys revealed that facebow transfer was an essential part in the fabrication of complete denture prosthesis, various evidences from clinical trials clinically opposed the use of facebow. Some RCTs have suggested that the facebow is not an integral part of complete denture fabrication, but saves the patients from inconvenient and tedious procedure.[14]

Ellinger *et al.* selected 64 patients and fabricated complete denture prosthesis for these patients using different techniques designated as "complex" and "standard." The complex procedures included the use of facebow for location of true hinge axis, whereas in standard procedure, facebow was not used. Parameters such as coincidence of centric relation with centric occlusion, stability and retention of maxillary and mandibular dentures, and condition of tissue-supporting dentures were assessed. The results showed no significant difference in the performance of prostheses fabricated from two different techniques.[10]

Table 1: Systematic review on the utility of facebow in the fabrication of complete denture prosthesis

Author and year	Title	Sample size	Strategy	Duration	Age group	Parameters evaluated	Place of study	Number of reviewers	Conclusion
Charles W Ellinger *et al*. (1979)	Patient response to variation in denture techniques. Part III: Five year subjective evaluation	64	Group I (complex): Facebow transfer, semi-adjustable articulator, adjusted to fully balanced occlusion Group II (standard): No facebow transfer, arbitrary mounting of maxillary cast, no attempt to balance the occlusion	Six recall visits in 5 years	-	Coincidence of centric relation with centric occlusion, stability, retention of maxillary and mandibular denture, condition of tissue-supporting dentures	Lexington	3	No significant difference
Nascimento *et al*. (2004)	Double-blind study for evaluation of complete dentures made by two techniques with and without facebow	5 (4 females, 1 male)	Group A: Facebow, Bioart semi-adjustable articulator, Paterson Tech Group B: No face bow, BPS articulator	10 days	-	Esthetics, comfort, stability, speech, and chewing	Valedo Paraiba	-	Tech without facebow gives better results in terms of esthetics, comfort, stability, patient satisfaction, and greater number of occlusal contacts in centric relation and left lateral movement
Kawai *et al*. (2005)	Do traditional technique produce better conventional complete dentures than simplified techniques	122	Group I: (traditional): Final impression with custom tray, face bow, semi-adjustable articulator Group II (simplified): No final impression, no facebow, monoplanal articulator	2 years' recall at 3 and 6 months	45-75	Satisfaction, comfort, and function assessed using VAS	Montreal, Canada		No difference
Heydecke *et al*. (2008)	Simplified versus comprehensive fabrication of complete denture : Patient ratings of denture satisfaction from cross over trial	20	Each participant was given two sets of complete dentures First pair: Tracing, facebow, semi-anatomic teeth with a lingualized and balanced occlusion pattern Second pair: Without facebow transfer, jaw relation with wax rims, anatomic teeth with canine and premolar guidance	3 months	-	General satisfaction, comfort, ability to speak, stability, esthetics, ease of cleaning, and ability to chew assessed using VAS	Germany	-	Patients rated their general satisfaction, denture stability, and esthetic appearance significantly better without the facebow and no significant difference in terms of ability to speak, comfort, chewing ability, and ease of cleaning of dentures.
Lt Col M Kumar (2010)	Comparative evaluation of two techniques in achieving balanced occlusion in complete dentures	20	Each participant was given two sets of complete dentures First pair: Facebow, semi-adjustable articulator Second pair: Semi-adjustable articulator without facebow transfer	10 days after denture delivery	-	Balanced occlusion, esthetics, function, and stability	1	India	Technique that avoids facebow presented better results with regard to time taken, esthetics, comfort, and stability
Cunha *et al*. (2013)	Randomized trial on simplified and conventional methods for complete denture fabrication: Masticatory performance and ability	39	Group S (simplified): No facebow transfer, single denture try-in Group C (conventional): Facebow transfer, semi-adjustable articulator, two denture try-in appointments	3 months	>40 years	Masticatory performance was assessed by calorimetric assay based on chewing Fuchsine-containing capsules and masticatory ability were assessed by a questionnaire with binary answers and single questions answered on a range of 0-10	Brazil	2	No difference
RR Regis *et al*. (2013)	Randomised trial of a simplified method for complete denture fabrication: Patient perception and quality	42	Group S: Absence of second set of impressions, no facebow transfer, single try-in appointment Group C: Second set of impressions, facebow transfer, two-stage try-in	3 months	47-80 years	OHRQoL, patient satisfaction, and denture quality	Brazil	4	Comparable

VAS: Visual analog scale, OHRQoL: Oral health-related quality of life

The limitations of this study include subjective evaluation of the patients and exclusion criteria not being mentioned.

Nascimento *et al.* conducted a double-blind study for evaluating complete dentures fabricated using two techniques, i.e., with and without facebow. Five patients were selected, and two pairs of complete dentures were fabricated for each individual using two different techniques.

Greater number of occlusal contacts in centric relation and left lateral movement were achieved in both the groups, and the number of occlusal contacts in centric and eccentric positions was registered and the opinion of patients regarding oral functions was recorded.

The study revealed that a technique without facebow gives better results in terms of esthetics, comfort, and stability. Limitations of this study include a small sample size of five participants, a short follow-up period of 10 days, and subjective rather than objective evaluation of oral functions, which made the study questionable.[11]

Kawai *et al.* conducted a randomized clinical trial with 122 patients and compared the quality of conventional complete denture fabricated with traditional (T) and simplified (S) methods. The traditional technique included use of facebow with a semi-adjustable articulator, whereas the simplified method included fabrication of prosthesis without the use of facebow. A visual analog scale was used to measure the patient satisfaction, comfort, and function at 3 and 6 months post insertion. This RCT concluded that there was no significant difference between the two groups in patients' rating and overall satisfaction. The strength of this study is a large sample size of 122 patients, satisfactory follow-up period of 3–6 months, and no effect of potential confounder (age, gender, edentulous period, and the treating prosthodontist) as assessed by multiple regression analysis.[12]

Heydecke *et al.* selected twenty patients and fabricated two sets of denture for each individual. One pair was fabricated based on facebow, tracing, and semi-anatomic teeth, and the other set was fabricated using simplified approach without the use of facebow. The prostheses were assessed for general satisfaction, comfort, stability, esthetics, and ability to chew, based on patient ratings after 3 months of denture insertion. The study concluded that no significant difference was observed between the two treatment methods. Limitations of this study include a small sample size of twenty participants, a short follow-up period of 3 months post insertion, and subjective rather than objective evaluation of oral functions, which made the study questionable.[13]

Kumar *et al.* selected twenty patients and conducted a study to compare complete dentures made by two techniques with and without the use of facebow. In the first technique, facebow and Hanau H2 semi-adjustable articulator H2 (Hanau Eng. CO. Buffalo USA) were used, whereas in the second technique, Stratos 100 semi-adjustable articulator (Stratos 100, Ivoclar, Liechteinstein) without a facebow transfer was used. Parameters such as comfort, stability, speech, and time taken for the fabrication of prosthesis were evaluated based on the questionnaire filled by the patients. The results concluded that the technique which did not made use of a facebow presented better results. Although the parameters were assessed objectively through a questionnaire in which three option were given, which did not give the patients a chance to decide a conclusive result, use of a 5- or 7-point ordinal scale such as a Likert scale could have given respondents a better opportunity to rate the degree to which they agree or disagree with the statement.[14]

Cunha *et al.* selected 39 participants and compared a simplified method to conventional protocol for complete denture fabrication regarding masticatory performance and ability to chew. The masticatory performance was evaluated by calorimetric assay based on chewing two capsules as test foods for different chewing cycles. The masticatory ability was assessed by a questionnaire with binary answers and a single question answered on a 0–10 scale. The study demonstrated no superiority of the facebow transfer in the fabrication of complete denture prosthesis in terms of masticatory performance.[15]

Regis *et al.* conducted a randomized control trial on selected 42 patients and compared a simplified (S) method for complete denture fabrication to conventional (C) protocols to estimate oral health-related quality of life (OHRQoL), patient satisfaction, and quality of denture. OHIP-EDENT instrument containing 19 questions was used to assess OHRQoL. An 8-item instrument was used to assess patient satisfaction. The simplified method reported better retention of mandibular denture and ability to speak at 3-month interval. The strength of this trial is that the parameters were assessed objectively using two different set of questionnaires.[16]

To summarize, out of the seven studies under the systematic review, studies by Ellinger *et al.*,[10] Kawai *et al.*,[12] Cunha *et al.*,[15] and Regis *et al.*[16] demonstrated no difference in outcomes when two techniques (simplified and

conventional) were used for the fabrication of complete denture prostheses.

Heydecke *et al.*[13] showed that patients rated their general satisfaction, denture stability, and esthetic appearance significantly better without the use of facebow, and there was no significant difference in terms of ability to speak, comfort, chewing ability, and ease of cleaning of dentures.

Nascimento *et al.*[11] and Kumar and D'Souza[14] demonstrated better results without the use of facebow.

This systematic review suggests that there is not enough scientific evidence to support the use of facebow in the fabrication of complete dentures to improve masticatory efficiency, minimize occlusal adjustment, reduce clinician time, improve stability, and retend or enhance patient satisfaction. However, the review of literature suggests that simplified methods without the use of facebow showed similar results in terms of denture stability, retention, masticatory efficiency, occlusal adjustments leading to increased patient satisfaction, and reduced clinician time, thereby improving the clinical efficiency and acceptability of complete denture prostheses.

The proponents of facebow transfer believe that it is absolutely essential in recording the patient's arc of closure and opening, which depends on the correct condylar axis position.[17] This helps to maintain the centric relation position, thereby producing a stable occlusion to maximize the structural and functional efficiency of the prosthesis. However, the scientific evidence shows that the opposite is true.

Assessing the risk of bias in the studies

Each study considered for the systematic review was analyzed independently by two members of the team. A third reviewer was consulted to arrive at a consensus in case of a doubt. A customized data extraction pro forma was used to extract the data and assess its quality. A review on fixed parameters was done, and risk of bias among various studies was checked by comparing various parameters such as selection bias, performance bias, detection bias, and attrition bias within each study. These were compared as high-risk, low–risk, and medium-risk bias. These risk biases were then analyzed statistically.

While assessing the risk of bias of the individual studies [Figure 2], it can be seen that out of seven studies under review, only three paid attention to and followed the elements of good clinical trial, two were partially acceptable, and two were poorly conducted. Figure 3 depicts the overall risk of bias in the studies, and the neglected elements were random sequence allocation, allocation concealment, and blinding the outcome investigator. Hence, it can be deciphered that the quality of trials under scrutiny was not impressive.

Strengths of this systematic review

This systemic review is structured with a well-designed PICOT question and clearly listed inclusion and exclusion criteria. Selection of the studies and data extractions were performed independently by two reviewers, and any disagreement was resolved by consultation with a third reviewer until consensus was achieved. The review is based only on the randomized controlled trials which are usually considered high-level evidence, which is the biggest strength of this review.

Limitation of this systematic review

The most important limitation of this systematic review is the absence of the quality assessment of the included studies, which is very important to estimate the level of evidence. Another point of weakness of this review is the absence of meta-analysis.

CONCLUSION

The use of facebow transfer for mounting the maxillary cast in relation to the hinge axis of temporomandibular joint was recommended and followed to produce more accurate clinical results over a period of time. Many dental schools mandated its use for all prosthodontic work. Hence,

Figure 2: Assessing the risk of bias in the studies at various stages of the review

	Random sequence allocation (selection bias)	Allocation concealment (selection bias)	Blinding of participants (performance bias)	Blinding of investigator (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Sample size	Other bias
Charles W Ellinger *et al*. (1979)	a	a	b	b	A	b	a	a
Nascimento *et al*. (2004)	c	c	a	a	A	b	c	a
Kawai *et al*. (2005)	a	a	a	c	A	a	a	a
Heydecke *et al*. (2008)	a	c	a	b	A	C	b	a
Lt Col M Kumar (2010)	c	c	b	c	B	b	b	c
Cunha *et al*. (2013)	a	a	b	b	A	b	a	a
RR Regis *et al*. (2013)	a	a	a	a	A	a	a	a

a: Low-risk bias, b: Medium-risk bias, c: High-risk bias

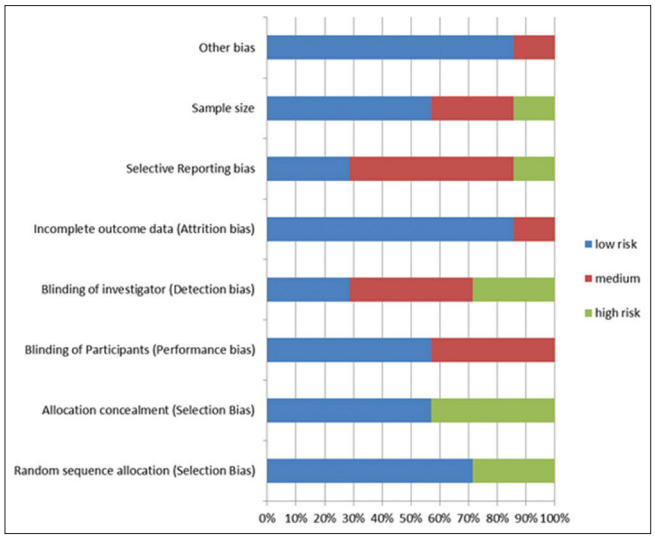

Figure 3: Overall risk of bias in the studies included in the present systematic review

this systematic review was undertaken to evaluate the utility of facebow transfer for complete denture fabrication to improve patient acceptability.

The number of randomized clinical trials on the utility of facebow was limited (n = 7). An extensive and a systematic search and analysis of the literature suggested that use of facebow is not an imperative step for recording orientation jaw relations, thereby producing clinically acceptable prostheses. All the RCTs assessed have exhibited similar results in terms of the various parameters essential for the success of a complete denture prosthesis. However, it is observed that the following may have contributed toward the similarity in results obtained using two techniques. These include insufficient sample size and recall period, nonstandardization of clinical steps, use of different instruments, subjective assessment of clinical parameters instead of quantitative or numerical evaluation, and reviewer bias due to single-blinded study design.

Recommendations

The present systematic review does not demonstrate the utility of facebow in improving patient's acceptability of the complete denture prostheses. However, it does not completely negate the use of the instrument because some of the factors exhibited similar outcomes. Hence, it is suggested that good-quality randomized clinical trials are required to achieve conclusive results. This can be done by designing the study protocol by eliminating the confounding factors, thereby selecting a larger sample size, broadly spaced recall visits, standardization of clinical protocol with instruments, objective assessment of the parameters, and elimination of reviewer bias. This would result in definitive outcomes in terms of comparison of two techniques used for the fabrication of complete denture prostheses, which would help in formulating a universally standardized protocol for the fabrication of clinically acceptable prostheses for completely edentulous patients.

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Conflicts of interest

There are no conflicts of interest.

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