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Evaluating Fixation Strategies for Ultra-Distal Tibial Fractures: A Comparative Analysis of Plate and Nail Techniques

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ABSTRACT

The management of ultra-distal tibial fractures which affect both the distal tibia's metaphyseal and epiphyseal areas remains difficult because of the difficult surgical anatomy combined with minimal bone availability together with exposed soft tissue. Multiple treatment options need careful evaluation for fixing these types of fractures to achieve the best results. The research compares the surgical results between distal tibial plate fixation and intramedullary nail fixation used for ultra-distal tibial fracture treatment. A research study used retrospective data from the Karachi Medical and Dental College during a period of February 2023 to August 2024. Two treatment groups included Group A (n=40) whose patients underwent distal tibial plating while Group B (n=40) received intramedullary nailing for their ultra-distal tibial fractures. This study examined union time along with malalignment measurement and functional outcomes using AOFAS score and recorded operative time and hospital stay period and complications between the two patient groups. The durations until bone union were similar between both groups as patients in the plating group needed 16.2±2.4 weeks while patients with nailing required 15.1±2.1 weeks (p=0.12). The plating group sustained malalignment in 5.6% of cases while the nailing group developed malalignment in 17.6% of cases (p=0.24). The patients in the plating group demonstrated AOFAS scores of 87.3 ± 6.8 which were comparable to those of 84.7±7.5 found in the nailing group (p=0.21). Patients underwent surgeries and hospitalization for shorter durations in the nailing group when compared to the plating group (p<0.05). Wound complications from the surface of the bone occurred more frequently in patients treated with plating techniques while hardware irritation developed more often in patients with nailing procedures. Both distal tibial plating and intramedullary nailing are effective options for managing ultra-distal tibial fractures. Plating offers better alignment control, while nailing provides advantages in surgical efficiency and early rehabilitation. The choice of fixation method should be based on fracture characteristics, soft tissue condition, and surgeon expertise.

Keywords: Ultra-distal tibial fractures, internal fixation, distal tibial plating, intramedullary nailing, comparative study

INTRODUCTION

Complete dentures continue to serve as a cornerstone in the rehabilitation of edentulous patients, significantly improving oral function, facial esthetics, and overall quality of life (Gonçalves, de Magalhães, Rocha, Dos Santos, & Assunção, 2022; Martins et al., 2024). Despite the advent of implant-supported prosthetics and advanced digital technologies, conventional complete denture fabrication remains an essential component of dental education and practice, particularly in regions where access to more sophisticated treatments is limited due to socioeconomic or logistical constraints (Martins et al., 2024; Bida et al., 2024). The success of complete dentures largely depends on four critical factors: retention, stability, support, and esthetics—each contributing uniquely to patient satisfaction and functional outcomes (Kutkut, Knudson, Bush, & Studts, 2024; Budală et al., 2023). Even minor deficiencies in any of these components can result in significant discomfort, dissatisfaction, and functional impairment for the patient. Dental undergraduate students, during their clinical training, are entrusted with the responsibility of fabricating dentures under the supervision of experienced faculty members (Sethi, Haq, Zaidi, & Baig, 2024; Durey, Lette, Saunders, Slack-Smith, & Community, 2022). This hands-on exposure is invaluable for developing clinical competency. However, the learning curve is steep, and the intricacies involved in denture fabrication often lead to various procedural and technical errors (Wu et al., 2022; Dimitrova, Vlahova, Kalachev, Kazakova, & Capodiferro, 2023). These errors, if not identified and corrected timely, can compromise the final prosthesis and reduce patient satisfaction. Conducting clinical audits of student work is therefore imperative—not only to maintain patient care standards but also to provide constructive feedback to students and improve the overall teaching methodology.

A clinical audit is a systematic and critical analysis of the quality of clinical care, including the procedures and outcomes, with the objective of improving future

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practice (Cappadona et al., 2023; Alghamdi et al., 2024). In dental education, it serves as a powerful quality assurance tool that identifies deviations from established clinical protocols, thereby enabling the formulation of corrective strategies (Alqarni & Aldrees, 2024; Frantsve-Hawley et al., 2022). In the context of prosthodontics, especially complete denture fabrication, audits can uncover trends in errors, link them to specific steps of the clinical process, and evaluate their impact on patient-related outcomes. (Leles, Silva, Curado, Schimmel, & McKenna, 2022; Gulabivala & Ng, 2023) Multiple studies have emphasized that patient satisfaction with dentures is a multi-factorial construct, often influenced by both technical accuracy and subjective esthetic expectations. Factors such as retention (how well the denture stays in place), stability (resistance to movement during function), support (distribution of forces to underlying tissues), and esthetic appearance (arrangement, shape, and shade of teeth) directly correlate with perceived comfort and acceptance (Sailer, Karasan, Todorovic, Ligoutsikou, & Pjetursson, 2022). The literature suggests that among these, occlusal interferences and poor polished surface finishing are common areas of concern in student-fabricated dentures, which not only diminish functional efficiency but also impair speech, mastication, and esthetic harmony.

Moreover, demographic characteristics of the patient, particularly age and gender, may subtly influence both the technical challenges encountered and the patient's subjective evaluation of the prosthesis (Lebleu et al., 2024; Calheiros-Lobo, Calheiros-Lobo, & Pinho, 2023). For example, older patients may have compromised ridge anatomy or neuromuscular coordination, making retention and stability harder to achieve, while esthetic expectations may vary between genders. Identifying whether a pattern of errors correlates with specific demographic variables can help clinicians and educators develop personalized protocols and targeted training to address common pitfalls more effectively.

Despite the importance of this subject, very few local studies in the Pakistani context have comprehensively evaluated the error frequency in complete denture fabrication by undergraduate students and its potential association with patient demographics. Given the growing number of dental institutions in the country and the increased demand for prosthodontic rehabilitation among an aging population, such audits are essential to bridge the gap between theoretical knowledge and clinical proficiency. Furthermore, with institutions like Lady Reading Hospital Peshawar serving as major teaching centers, an evidence-based assessment of student clinical work becomes a vital component of curricular enhancement.

This was thus a study to clinically audit the errors in complete denture fabrication by BDS undergraduate students at the final insertion stage pertaining to the important domain's denture satisfaction namely retention, stability and support, and esthetics. Senior faculty members totaled 163 dentures, both maxillary and mandibular, and error frequencies were recorded against standardized clinical criteria. The nature and frequency of procedural shortcomings were also analyzed regarding association with patient age and gender to see if these demographic variations had an impact on the errors.

This audit will not only help in the continuing effort to increase dental education and prosthodontic care, but also lead the direction for learning that is standardized in a more outcome-based way. Finally, such audits directly contribute to the dual objectives of quality patient care and excellent practice by future dental practitioners.

METHODOLOGY

It is a cross sectional observational clinical audit in the Karachi Medical and Dental College, a tertiary care teaching hospital of a recognized dental institution. The focus of the audit was to assess the frequency of error in complete denture fabrication by undergraduate students and to explore the relationship between error and patient demographic factors (age and gender). The study was run from January 10, 2024 to September 10, 2024.

There were 163 complete dentures (M = 80; mandibular, M = 80; maxillary). Final year Bachelor of Dental Surgery (BDS) student fabricated all the dentures under the close supervision of experienced prosthodontic faculty members. The study included only those patients who had reached the final insertion stage of their dentures and who had approved giving their consent. We had inclusion criteria that patients be completely edentulous, have dentures made by undergraduate students in the dental school under institutional supervision, be evaluated at insertion stage at final insertion stage, and have provided informed consent. Patients with past or present medical or psychological conditions which could potentially effect denture satisfaction were also excluded; patients who were willing and able to comply but who were lost to follow up prior to prosthetic insertion were excluded; patients with partially edentulous records, dentures fabricated by house officers, postgraduate trainees or faculty and; patients who either did not participate, or were lost to follow up on the date of insertion.

Senior prosthodontic clinicians that were not involved in fabrication performed the denture assessments so they were not biased. Final insertion appointments were performed in the dental chair while the patients were seated comfortably. A structured checklist to evaluate dentures was developed and used to appraise four core subjects: retention, stability, support, and esthetics crucial for denture satisfaction. One of the domains of retention discussed was over extension or under extension of buccal or lingual flanges or if insufficient post dam area was provided. Proper artificial teeth setup, absence of occlusal interferences and proper extension of flanges into vestibular sulcus was performed and stability was assessed. Finally, support

was judged by how well the denture base fitted to under lying tissues, extension of dentures over favorable tissue areas, and accuracy of the final impression. Polished surface finishing, choice of tooth shape and shade and accuracy of tooth arrangement were evaluated through esthetics. According to predefined clinical standards and professional judgment, each parameter was rated as error present or error absent.

Demographic data for each patient included age (grouped into years) and gender. In addition to denture evaluations, we also recorded demographic data. Data was collected and all collected data were entered in the Statistical Package for the Social Sciences (SPSS) version 25.0 for analysis. For each type of denture error, frequencies and percentages were calculated for descriptive statistics. Demographic associations with denture fabrication errors were assessed inferentially using statistical methods. In particular, the Chi square test was used to ascertain the relationship between error types and the categories like gender while Pearson's correlation coefficient is used to gauge the relationship between age and denture related parameters. Statistical significance was determined to be less than 0.05 for a p value.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of Lady Reading Hospital, Peshawar. Written informed consent was obtained from all participating patients. Confidentiality and anonymity of both patients and students were strictly maintained throughout the study process.

RESULTS

This clinical audit evaluated a total of 163 complete dentures, including 80 maxillary and 80 mandibular dentures, fabricated by undergraduate dental students at the final insertion stage. The study assessed errors in four core domains affecting denture satisfaction: retention, stability, support, and esthetics. The demographic variables of age and gender were analyzed in relation to the frequency of errors.

Table 1 Distribution of Patient Demographics

Variable	N	Percentage (%)
Gender		
Male	82	50.3%
Female	81	49.7%
Age Group		
< 50 years	47	28.8%
50–60 years	56	34.4%
> 60 years	60	36.8%

Figure: 1

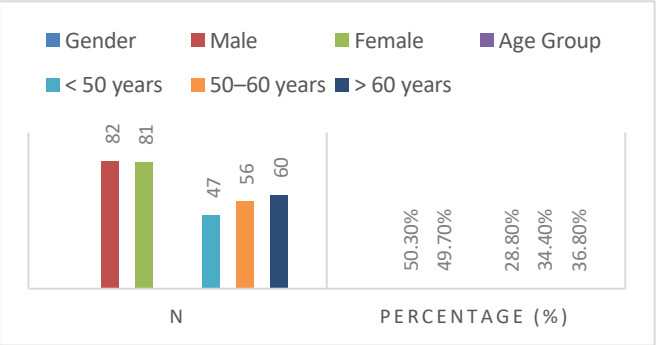


Table 2: Frequency of Errors in Denture Parameters Retention-Related Errors

Parameter	Error Frequency (n)	Percentage (%)
Overextended buccal/lingual flanges	21	12.9%
Underextended buccal/lingual flanges	19	11.6%
Inadequate post-dam area	17	10.4%

Figure: 2

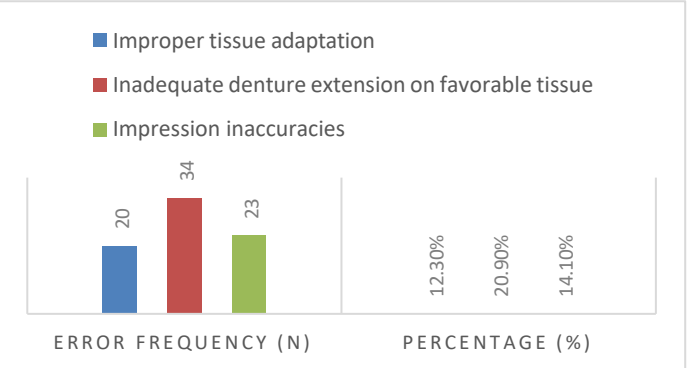


Table 3: Stability-Related Errors

Parameter	Error Frequency (n)	Percentage (%)
Incorrect setup of teeth	29	17.7%
Occlusal interferences	104	64.0%
Improper flange extension in sulci	26	15.9%

Figure: 3

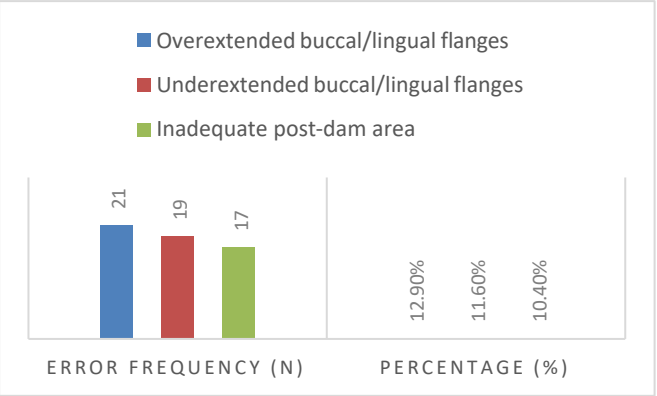


Table 4: Support-Related Errors

Parameter	Error Frequency (n)	Percentage (%)
Improper tissue adaptation	20	12.3%
Inadequate denture extension on favorable	34	20.9%
Impression inaccuracies	23	14.1%

Figure: 4

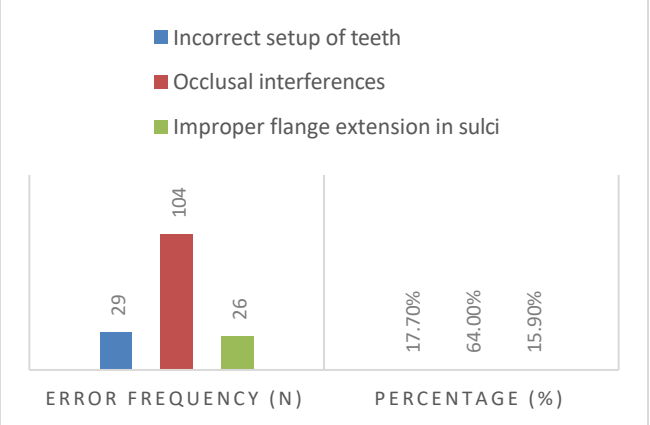


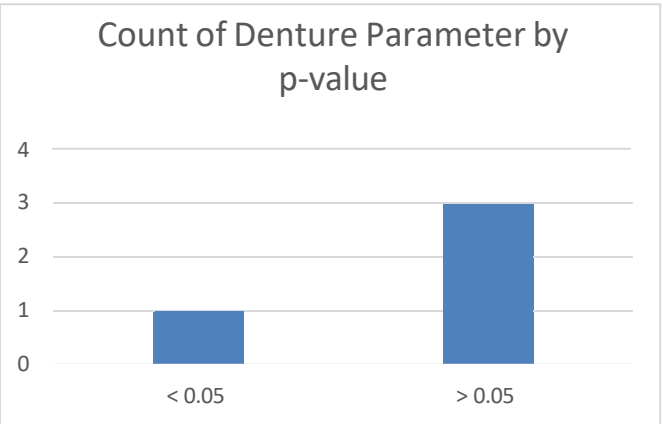
Table 5: Esthetics-Related Errors

Parameter	Error Frequency (n)	Percentage (%)
Polished surface finishing	123	75.2%
Tooth shape and shade selection	19	11.6%
Inaccurate arrangement of teeth	27	16.5%

Table 6: Association of Errors with Gender

Denture Parameter	p-value
Retention (all parameters)	> 0.05
Stability (all parameters)	> 0.05
Esthetics (all parameters)	> 0.05
Support – Extension on favorable tissue	**< 0.05**

Figure . 6



4. Correlation of Errors with Age

Denture Parameter	p-value
Retention	> 0.05
Stability	> 0.05
Support	> 0.05
Esthetics – Tooth shape/shade	**< 0.05**

The study revealed that occlusal interferences (64.0%) and errors in polished surface finishing (75.2%) were the most commonly observed issues in the denture fabrication process. Gender did not show a significant association with most of the identified errors, with the exception of support-related extension. Additionally, age was found to be significantly correlated only with tooth shape and shade selection within the esthetics domain.

RESULTS

The purpose of this clinical audit was to determine the frequency of errors made by undergraduate dental students whilst fabricating complete dentures and between patient demographics, specifically age and gender. They systematically analyzed the parameters influencing denture satisfaction under four domains — retention, stability, support and esthetics. The results obtained in the present study help to identify areas in which clinical training of dental students needs refinement and especially areas of weakness within the denture fabrication process that could directly influence patient satisfaction.

Relative low percentages were shown by retention related errors, such as overextension or under extension of flanges, or inadequate post dam areas. This suggests that undergraduate students already have a basic clinical understanding of how anatomical considerations are needed to get good retention. This concurs with the findings of Nisha et al. (2020) who reported that students perform well in gross anatomical steps, but struggle with more subtle aspects of occlusion and esthetic detailing.

In addition, errors may be less frequent in this domain because flange extension and post dam placement are ordinarily supervised or adjusted by instructors and thus are less likely to result in disastrous errors. It intimates that students can, with proper guidance and supervision, master basic prosthodontic skills.

The high prevalence (64%) of occlusal interferences was one of the most notable findings in this study, as it reached the highest prevalence, clearly becoming the most common error within the domain of stability. This suggests a major weakness in occlusion related clinical judgment among undergraduate students. If occlusal interferences are allowed to persist, patients can suffer poor mastication, discomfort, and different failure with dentures. As concluded by Kapur et al. (2018), occlusal discrepancies are an important reason for patient complaints and postinsertion adjustments.

That trend suggests training may fall short in the areas of occlusion analysis and articulation. Setting teeth accurately on the occlusal plane requires clinical dexterity and theoretical understanding and this is an

area that may derive benefit from improved pre-clinical simulation, chairside mentoring and repeated exposure during prosthodontic rotations.

Patient gender significantly associated with support extension on favorable tissue among the parameters determining support ($p<0.05$). The exact causative factor for this association cannot be immediately identified, but there may be possible reasons for this, namely due to anatomical differences in alveolar ridge and soft tissue contours and alveolar ridge development, which could pose different challenges in impression taking and base adaptation. In contrast to Muneer et al. (2017) this observation is not consistent with the fact that they, in their study, did not find any gender-based differences in denture support errors.

Thus, error rates in other support parameters like tissue adaptation and impression accuracy are relatively moderate, indicating a sufficiently good, albeit improvable, performance level. More emphasis needs to be placed on accurate impression taking techniques and custom tray use which are foundational to providing effective denture support.

Overall, the parameter of polished surface finishing had the highest error percentage (75.2%). Our findings in this study represent a major oversight in the last stages of denture fabrication by passing over surface texture and finishing. Polished surface irregularities interfere with speech, retention, and esthetic appeal, key factors of patient satisfaction. This echoes earlier work by Singh et al. (2019) who highlighted how students frequently neglect to see the importance of finishing and polishing in their initial clinical training.

Interestingly, although the errors associated with the tooth shape, shade selection, and the appropriate arrangement were less, the tooth shape/shade selection parameter was closely correlated with patient age ($p < 0.05$). This indicates that older patients will have more complex esthetic expectations or anatomical limitations, making selection of appropriate shades and forms more challenging for students. Clinical curricula need to be reinforced with the importance of age appropriate esthetic planning.

Clinical Implications and Educational Consideration

The results of this study highlight important weaknesses within the process of denture fabrication that are often overlooked in undergraduate dental training. Specifically, modules on occlusal adjustments and esthetic finishing need to be more delineated and structured to determine competence. Implementation of regular objective checklists and clinical audits in all dental institutions would effectively help identify and resolve performance gaps. In addition, it should also cover more than the first phase of impression making to impressure media; it should also go up to the last phase of prosthesis deliver, in which most of the error, like finishing error, occur. The approach can further improve clinical precision by integrating digital prosthodontic tools, such as CAD/CAM training, and incorporating feedback-based learning strategies.

Limitations

It offers us a lot of insights but the study has its limitations which one must consider. Its findings may lack generalizability to other institutional settings, and were derived as a single-center sample. In addition, clinical evaluations were done by experienced faculty, and the inherently subjective nature of such evaluations may give rise to inter examiner variability. Future research should integrate digital assessment tools, and include long term follow up to understand the effects of clinical errors on patient satisfaction, and the long-term performance of dentures.

CONCLUSION

In conclusion, this study emphasizes that while undergraduate dental students demonstrate satisfactory skills in basic denture retention and support, considerable deficiencies exist in occlusal accuracy and esthetic finishing, both of which are critical for patient satisfaction. A structured, feedback-based approach in clinical training with greater attention to fine prosthodontic details is essential for improving outcomes and developing competent future practitioners.

Ethical Approval

ERB/KMDC/DU/012023

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