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Original Research

A Comparative Computerized Occlusal Analysis of Conventional Complete Denture and Single Implant Retained Mandibular Overdenture

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ABSTRACT:

Objectives: This study aimed to compare the occlusal characteristics of conventional complete dentures (CCD) and single implant-retained mandibular overdentures (SIMO) using computerized occlusal analysis over a six-month period. **Materials and Methods:** A randomized controlled study included 22 edentulous patients divided into SIMO (n=11) and CCD (n=11) groups. Randomization used computer-generated tables.Dentures were fabricated following standardized protocols, with post-insertion occlusal adjustments. Digital occlusal analysis (T-Scan) was performed at three time points: 48 hours (T1), 3 months (T2), and 6 months (T3) post-insertion. The primary outcomes measured were the number of occlusal tooth contacts, percent biting occlusal force, percent bilateral force difference (left vs. right), and percent force distribution on left and right sides. Independent t-tests compared groups at each time point ($p<0.05$). For longitudinal analysis, repeated measures ANOVA assessed changes from T1 to T3 within groups. **Results:** No significant differences were observed between groups in terms of number of occlusal contacts ($P>0.05$), percent biting occlusal force ($P>0.05$), percent bilateral force difference ($P>0.05$), and percent force distribution ($P>0.05$) at all time points. **Conclusions:** The findings suggest that CCD and SIMO provide comparable occlusal performance over six months when properly adjusted. Clinicians may consider patient-specific factors such as cost, comfort, and anatomical conditions rather than occlusal outcomes alone when selecting between these treatment options.

Keywords- Complete denture, Implant overdenture, Occlusal analysis, T-Scan

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INTRODUCTION

The rehabilitation of completely edentulous individuals is increasingly necessary due to factors such as longer life expectancy, greater awareness of dental treatment, and the high prevalence of edentulism (1). Despite a strong interest in rehabilitation, economic constraints often lead to the widespread use of conventional complete dentures (2). The McGill consensus recommends using two implants to support mandibular overdentures (3); however, this approach is often not feasible. Recently, there has been growing interest in single implant-supported overdentures, which offer economic advantages, a simplified procedure, and favorable patient outcomes (4,5).

Critical to the success of any prosthesis, whether complete dentures or implant-supported overdentures, is the proper occlusal scheme (6). Bilateral balanced occlusion is commonly suggested (7), but challenges such as micromovements of the prosthesis and changes in diet or habits can affect occlusion over time (8). Premature occlusal contacts, if not addressed, can lead to instability, mucosal lesions, and long-term complications like ridge resorption and prosthesis failure (9,10).

Traditional methods for occlusal analysis, such as articulating paper, lack accuracy and objectivity (11,12). The introduction of computerized occlusal analysis systems provides a more reliable means to evaluate occlusal forces and contact distribution, offering both qualitative and quantitative insights into

occlusal function (13,14). This study aims to compare changes in occlusal force and contact distribution between conventional complete dentures and single implant-retained mandibular overdentures using computerized occlusal analysis at various time intervals after insertion.

MATERIALS AND METHODS

This randomized controlled trial compared the occlusal performance of single implant-retained mandibular overdentures (SIMO) and conventional complete dentures (CCD) in completely edentulous patients, adhering to CONSORT guidelines for transparent reporting. The study was conducted at the Division of Prosthodontics, Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, after obtaining ethical approval (IECPG-654/25.11.2020) and CTRI registration (CTRI/2021/04/033054). As a pilot investigation, formal sample size calculation was not performed, and all eligible patients during the recruitment period (August 2020-December 2021) were enrolled. The study prioritized methodological rigor through standardized operative procedures, blinded outcome assessment where feasible, and strict ethical protocol adherence.

Twenty-two participants were randomly allocated into two groups (SIMO: n=11; CCD: n=11) using computer-generated block randomization with concealed allocation via sequentially numbered opaque envelopes. Inclusion criteria included patients aged 50-74 years, completely edentulous for 6-12 months, with adequate mandibular bone (≥10 mm height, ≥4.5 mm width), Class I jaw relationship, and no prior denture experience. Exclusion criteria included systemic/metabolic disorders, temporomandibular joint dysfunction, head/neck radiation history, substance abuse, or poor implant stability (<30 Ncm).

In the SIMO group, implants were placed using CBCT-guided surgical templates via an open-flap technique under local anesthesia (Figure 1,2), achieving 30-35 Ncm insertion torque, and retained with ball attachments (Figure 3,4). The CCD group received conventionally fabricated dentures. Both groups followed identical prosthetic protocols for denture fabrication, except for implant placement in SIMO. Occlusal analysis was performed using a computerized system (Figure 5) at 48 hours (T1), 3 months (T2), and 6 months (T3) post-insertion, assessing number of occlusal tooth contacts, percent biting occlusal force, percent bilateral force difference (left vs. right), and percent force distribution on left and right sides. Adjustments were made using articulating paper as needed. Data were analyzed using Stata 14.0, with intergroup comparisons via independent t-tests and intragroup changes assessed using repeated measures ANOVA ($p < 0.05$). All procedures were performed by a single operator to ensure standardization, and all enrolled participants completed the 6-month follow-up without attrition.

RESULTS

This study compared occlusal stability between single-implant overdentures (SIMOs) and conventional dentures (CCDs) across three timepoints (T1:48h, T2:3mo, T3:6mo). Intragroup analysis (Table 1) via repeated measures ANOVA revealed no significant temporal changes in either group for occlusal contacts (SIMO P=0.73; CCD P=0.54), force distribution (SIMO left P=0.14/right P=0.59; CCD left/right P=0.27), bilateral force difference (SIMO P=0.45; CCD P=0.32), or biting force (SIMO P=0.98; CCD P=0.95), confirming treatment stability over time. Intergroup comparisons (Table 2) using unpaired t-tests demonstrated no significant differences between SIMOs and CCDs at any time point for occlusal contacts (T1 P=0.66; T2 P=0.63; T3 P=0.97), force distribution (left side T1-T3 P=0.37-0.90; right side P=0.37-0.90), bilateral force difference (T1 P=0.23; T2 P=0.47; T3 P=0.87), or biting force (T1 P=0.70; T2 P=0.60; T3 P=0.48), with all 95% CIs crossing zero and effect sizes indicating trivial-to-small differences (Graph 1). These findings suggest equivalent occlusal performance between SIMOs and CCDs during the 6-month observation period.

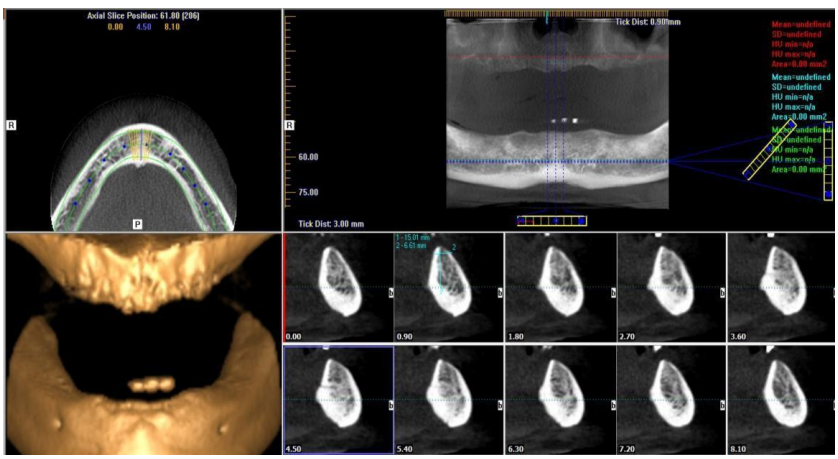

Figure 1

Figure 2

Figure 3

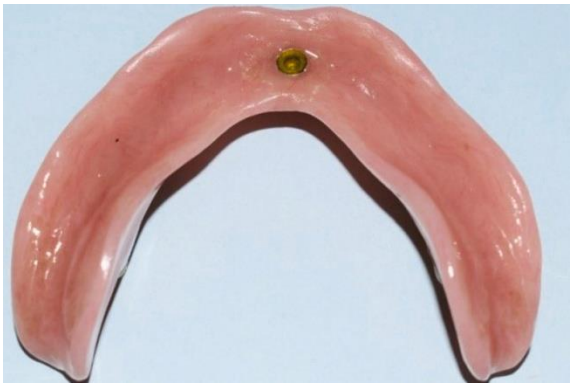

Figure 4

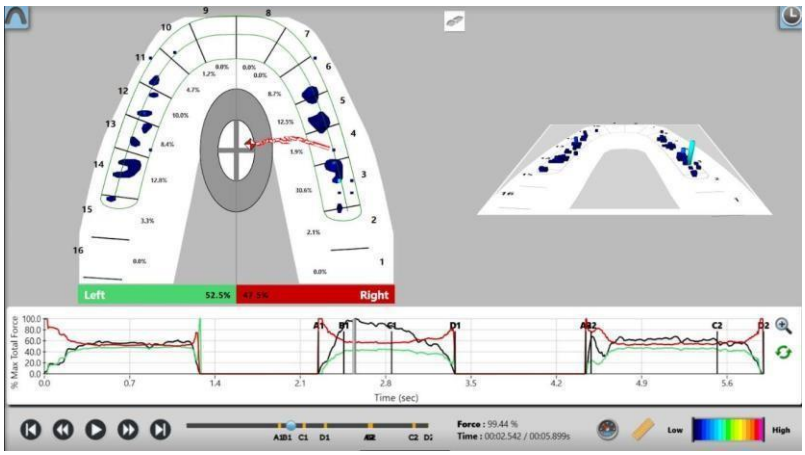

Figure 5

Table 1: Intragroup Comparison of Occlusal Function Parameters in SIMO (Single Implant-retained Mandibular Overdenture) and CCD (Conventional Complete Denture) Patients Across Follow-Up Periods

Group	Variable	T1 (48h)	T2 (3mo)	T3 (6mo)	F-value	*P*-value
SIMO	Occlusal Contacts	17.36 ± 1.69	17.27 ± 3.00	17.64 ± 3.17	0.01	*0.73*
SIMO	Left Force (%)	52.34 ± 2.23	51.64 ± 1.62	52.48 ± 1.84	2.21	*0.14*
SIMO	Right Force (%)	47.66 ± 2.23	48.36 ± 1.62	47.52 ± 1.84	0.56	*0.59*
SIMO	Bilateral Force Difference	4.91 ± 3.98	3.18 ± 3.03	4.96 ± 3.68	0.01	*0.45*
SIMO	Biting Force	99.02 ± 0.69	99.06 ± 0.49	99.07 ± 0.55	0.01	*0.98*
CCD	Occlusal Contacts	16.80 ± 3.85	17.90 ± 2.96	17.60 ± 2.71	0.02	*0.54*
CCD	Left Force (%)	51.16 ± 3.56	51.80 ± 0.60	52.40 ± 1.13	1.42	*0.27*
CCD	Right Force (%)	48.84 ± 3.56	48.20 ± 0.60	47.60 ± 1.13	1.43	*0.27*
CCD	Bilateral Force Difference	1.99 ± 6.84	3.89 ± 1.05	4.74 ± 2.15	0.02	*0.32*
CCD	Biting Force	99.16 ± 1.01	99.25 ± 1.07	99.25 ± 0.65	0.05	*0.95*

Table 2: Intergroup Comparison of Occlusal Function Parameters (Unpaired t-test results; SIMO = Single Implant-Supported Overdenture, CCD = Conventional Complete Denture)

Parameter	Time	SIMO (Mean ± SD)	CCD (Mean ± SD)	Mean Difference (95% CI)	P-value
Occlusal Tooth Contacts	T1	17.36 ± 1.69	16.80 ± 3.85	0.56 (-2.11, 3.23)	0.66
	T2	17.27 ± 3.00	17.90 ± 2.96	-0.63 (-3.35, 2.10)	0.63
	T3	17.64 ± 3.17	17.60 ± 2.72	0.04 (-2.67, 2.75)	0.97
Biting Occlusal Force (%)	T1	99.02 ± 0.69	99.16 ± 1.01	-0.14 (-0.92, 0.64)	0.70
	T2	99.06 ± 0.49	99.25 ± 1.07	-0.19 (-0.94, 0.56)	0.60
	T3	99.07 ± 0.55	99.25 ± 0.65	-0.18 (-0.73, 0.36)	0.48
Bilateral Force Difference (%)	T1	4.91 ± 3.98	1.99 ± 6.84	2.92 (-2.24, 7.59)	0.23
	T2	3.18 ± 3.03	3.89 ± 1.05	-0.71 (-1.14, 5.22)	0.47
	T3	4.96 ± 3.68	4.74 ± 2.15	0.22 (-2.49, 7.43)	0.87
Left Side Force (%)	T1	52.34 ± 2.23	51.16 ± 3.56	1.18 (-1.51, 3.86)	0.37
	T2	51.64 ± 1.62	51.80 ± 0.60	-0.16 (-1.30, 0.97)	0.76
	T3	52.48 ± 1.84	52.40 ± 1.13	0.08 (-1.33, 1.49)	0.90
Right Side Force (%)	T1	47.66 ± 2.23	48.84 ± 3.56	-1.18 (-3.86, 1.51)	0.37
	T2	48.36 ± 1.62	48.20 ± 0.60	0.16 (-0.97, 1.30)	0.76
	T3	47.52 ± 1.84	47.60 ± 1.13	-0.08 (-1.49, 1.33)	0.90

DISCUSSION

The study results supported the null hypotheses, demonstrating no statistically significant differences in occlusal parameters between conventional complete dentures (CCDs) and single implant-retained mandibular overdentures (SIMOs) over the six-month observation period (1). At 48 hours post-insertion, occlusal contacts averaged 16.80 ± 3.85 for CCDs and 17.36 ± 1.68 for SIMOs ($P > 0.05$), with comparable stability maintained at 3 and 6 months (2). This consistency likely reflects the effectiveness of bilateral balanced occlusion achieved through laboratory remounting procedures, a finding consistent with previous reports suggesting such stability typically persists for at least one year before requiring rebalancing (3). The mucosal resiliency observed in our study participants further contributed to this stability by accommodating minor occlusal discrepancies, supporting earlier observations by Heartwell and Rahn regarding tissue adaptation (4).

Masticatory efficiency, quantified through percentage mean biting force, showed remarkable similarity between groups at all evaluation points (5). Initial values of 99.16 ± 1.00% for CCDs and 99.02 ± 0.68% for SIMOs ($P > 0.05$) with minimal subsequent fluctuations suggest both prosthetic approaches facilitate comparable functional adaptation (6). These findings align with Borie et al.'s documentation of

force pattern stabilization within the first month of denture use (7).

Force distribution analysis revealed consistent bilateral balance in both treatment modalities (8). The <10% discrepancy threshold for adequate occlusion, as proposed by Floriani et al., was consistently maintained throughout the study period (9). Notably, the single implant in SIMOs did not compromise occlusal harmony, indicating that proper attachment selection and occlusal adjustment can effectively balance the different support mechanisms (mucosal versus ridge support) of these prostheses (10).

While these results demonstrate equivalent short-term occlusal performance, several limitations warrant consideration (11). The six-month follow-up period precludes assessment of long-term outcomes, and the modest sample size may limit generalizability. Furthermore, the T-Scan system's inability to measure absolute forces or dynamic occlusal patterns suggests areas for methodological refinement in future investigations (12). Nevertheless, our findings corroborate existing evidence that both CCDs and SIMOs can provide satisfactory functional outcomes when meticulously fabricated and adjusted (13).

CONCLUSIONS

Within the limitations of this study, there were no significant differences between single implant-supported mandibular overdentures (SIMOs) and conventional complete dentures (CCDs) in terms of occlusal parameters, including occlusal contacts, biting force, force distribution, and bilateral force difference, over six months. Both treatments demonstrated comparable outcomes when bilateral balanced occlusion was implemented.This suggests that the choice between SIMOs and CCDs can be guided by other clinical or patient-specific criteria, as both provide similar occlusal functionality and stability in centric occlusion.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization: Goel A*, Jain V;
Methodology: Koli DK, Jain V, Nanda A;
Formal Analysis: Koli DK, Jain V, Nanda A;
Investigation: Jain V, Nanda A;
Resources: AlIMS New Delhi;
Writing – Original Draft: Goel A*, Jain V, Nanda A;
Writing – Review & Editing: Goel A*, Koli DK;
Supervision: Koli DK, Jain V, Nanda A.

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