RESEARCH PAPER

Use Of Digitally Guided Orthodontics To Improve Periodontal Impact Of Treatment

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ABSTRACT

Orthodontic treatment in patients with periodontitis requires careful biomechanics and meticulous plaque control to avoid worsening of the periodontal condition, and recent evidence suggests that digitally guided workflows may help optimize both aspects. Therefore the aim of our study was to evaluate whether digitally guided orthodontics improves periodontal outcomes compared with conventional orthodontic planning in adults with mild to moderate periodontitis. A total of 100 patients with mild to moderate periodontal involvement and malocclusion were randomly assigned to digitally guided (Group A, n=50) or conventional (Group B, n=50) orthodontic treatment after non-surgical periodontal therapy and standardized hygiene instructions. After which, plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing pocket depth (PPD), clinical attachment level (CAL) and gingival recession (GR) were recorded at baseline, 3 months, 6 months and 12 months, along with patient reported outcomes. We found that Group A showed significantly greater reductions in PI, GI, BOP, PPD, GR, gain in CAL and higher treatment satisfaction at 12 months. We conclude that digitally guided orthodontics, when integrated with periodontal phase up and structured monitoring, leads to better periodontal and patient reported outcomes than conventional planning.

Keywords: Periodontal Condition, Orthodontic Treatment, Digitally Guided, Conventional Planning, Patient Reported Outcomes.

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INTRODUCTION

Orthodontic treatment in patients with existing periodontal involvement poses a unique challenge, as tooth movement can either exacerbate gingival inflammation and attachment loss or, when carefully planned, improve periodontal health by facilitating better plaque control and occlusal harmony. The integration of digitally guided orthodonticsusing intraoral scans, 3D virtual setups, and clear-aligner-based or digitally planned fixed-appliance systems has recently been proposed as a promising strategy to minimize periodontal stress while still achieving stable orthodontic outcomes.[1-3] Evidence from past studies had showed that the digital workflows and remote monitoring can enhance plaque control, reduce gingival inflammation, and partially

improve probing pocket depth and clinical attachment level in periodontitis-affected adults, even in advanced stages of periodontal disease.[4-6] Despite these encouraging data, there remains limited prospective comparative evidence on how digitally guided orthodontics influences key periodontal indicessuch as plaque index, bleeding on probing, PPD, and CAL in a well-defined, stage-I–III periodontitis population managed in a routine clinical setting like that of Rajasthan, India. Thus, this present study was designed to evaluate the use of digitally guided orthodontics to improve the periodontal impact of treatment in 100 adult patients with mild-to-moderate periodontal involvement and malocclusion, by comparing a digitally guided orthodontic protocol (integrating intraoral scanning, 3D-virtual diagnostic setup, and digital-based monitoring) with a conventional plaster-model-based orthodontic approach, under standardized periodontal-phase-up and hygiene-instruction conditions.

AIM

To assess whether digitally guided, periodontally dominated orthodontic treatment using intraoral scans, 3D models, Meshmixer-based virtual planning, and DentCare Aligners improves periodontal outcomes.

MATERIALS AND METHOD

A prospective comparative clinical study was conducted in 100 adult patients of Rajasthan, India with mild-to-moderate periodontal involvement and malocclusion. They were then randomly assigned into to two equal groups of 50 each i.e. Group A (digitally guided orthodontics) and Group B (conventional orthodontics). At baseline, all participants will undergo standardized periodontal assessment including plaque index (PI), gingival index (GI), bleeding on probing (BOP %), probing pocket depth (PPD), clinical attachment level (CAL), and gingival recession(GR) at six sites per tooth, along with routine orthodontic records (intraoral scans or models, radiographs, and photographs). Moreover, prior to appliance placement, all patients received non-surgical periodontal therapy(NSPT) to stabilize gingival inflammation and was given identical oral-hygiene instructions to minimize confounding by differential plaque control.

Furthermore, group A received the treatment and monitored through a digital workflow including intraoral scanning, 3D virtual diagnostic setup as shown in figure 1 & 2 with digital-guided positioning, supported by structured digital monitoring (e.g., app-based or photo-based telemonitoring) at 4- to 6-week intervals to reinforce oral-hygiene behavior and track gingival changes. Group B was managed with conventional plaster-model-based diagnosis and standard fixed or removable appliances without digital setup guidance, relying only on routine clinical check-ups without any formalized digital monitoring system. Periodontal parameters and patient-reported outcomes (discomfort, difficulty in maintaining hygiene, treatment satisfaction) will be reassessed at (F0)basline, (F1)3, (F2)6, and (F3)12 months after appliance placement.

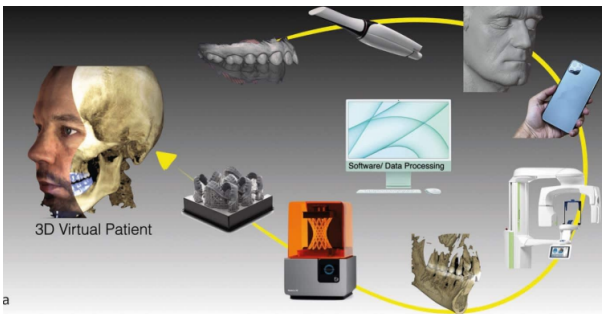

FIGURE 1 : ***DIGITAL-WORKFLOW DIAGRAM LINKING MANUAL PERIODONTAL PROBING, INTRAORAL SCANNING, 3D MODELING, VIRTUAL TREATMENT PLANNING USING MESHMIXER (AUTODESK INC., USA), AND DENTCARE ALIGNERS–BASED ORTHODONTIC APPLIANCES. PROBING POCKET DEPTH AND BLEEDING ON PROBING ARE FIRST RECORDED CLINICALLY, THEN INTEGRATED INTO A 3D VIRTUAL DENTAL MODEL; TREATMENT IS PLANNED IN MESHMIXER TO MINIMIZE PERIODONTAL STRESS, AND DENTCARE ALIGNERS ARE FABRICATED TO EXECUTE THE DIGITALLY GUIDED.***

FIGURE 2: 3D DENTAL SCANNER

INCLUSION CRITERIA

1. 18-55 years of age
2. Stage I-III periodontitis (according to the 2017 AAP/EFP classification).
3. Presence of malocclusion (crowding, spacing, mild Class I/II/III, or localized displacement) requiring comprehensive or limited orthodontics.
4. Atleast 20 natural teeth present (excluding 3rd molar)
5. Systemically healthy or medically controlled (e.g., stable hypertension, well-controlled diabetes mellitus on medication) without contraindications for periodontal and orthodontic therapy.
6. Completed or planning to complete stage-I periodontal therapy (scaling and root planing and oral-hygiene education) before appliance placement.
7. Motivated and compliant patients willing to attend regular follow-up visits (every 4–6 weeks) and maintain good oral hygiene.
8. No active orthodontic treatment on the same arch within the last 5 years.

EXCLUSION CRITERIA

1. Untreated or unstable Stage-IV periodontitis, or rapidly progressing/aggressive periodontitis.
2. Severe systemic conditions affecting periodontal health or bone metabolism (e.g., uncontrolled diabetes, severe osteoporosis, active malignancy, rheumatologic disease on high-dose immunosuppressants).
3. Current use of medications that significantly affect periodontal tissues or bone remodeling (e.g., intravenous bisphosphonates, tyrosine kinase inhibitors, or long-term high-dose corticosteroids).
4. Heavy smoking (>10 cigarettes/day) or substance abuse impairing periodontal healing.
5. Pregnancy or lactation
6. Need for orthognathic surgery (severe skeletal Class II or Class III requiring jaw surgery).
7. Severe pulpal or periapical pathology involving the marginal periodontium of the teeth planned for orthodontic movement.
8. Previous full-arch orthodontic treatment within the last 5 years on the same arch.

STATSICAL ANALYSIS

Statistical analysis was performed on 100 patients using an intention-to-treat approach, with descriptive statistics (mean ± SD or median [IQR]) and frequencies for baseline and follow-up data. Within-group changes in PPD, CAL, BOP %, PI, and GI over 12 months will be assessed using repeated-measures ANOVA or mixed-effects models (with post-hoc tests); non-normal data will be analyzed using Friedman and Wilcoxon tests. Between-group differences at each visit, especially at 12 months, was done using independent-samples t-tests or Mann-Whitney U tests and Chi-square/Fisher's exact tests, and mixed-effects models with group, time, and baseline-covariate effects was evaluated for the impact of digitally guided on periodontal outcomes ($p < 0.05$, effect sizes as Cohen's d).

RESULT

PARAMETER	GROUP A	GROUP B	WITHIN GROUPS (F0-F3) P value	BETWEEN GROUPS (F3) P value
PI (F0)	1.87 ± 0.41	1.85 ± 0.43	-	0.872
PI (F3)	1.21 ± 0.32	1.47 ± 0.36	<0.001 (A), 0.003 (B)	<0.001
GI (F0)	1.70 ± 0.43	1.68 ± 0.45	-	0.794
GI (F3)	1.10 ± 0.30	1.34 ± 0.35	<0.001 (A), 0.002 (B)	0.002
BOP% (F0)	46.2 ± 12.1	46.8 ± 13.0	-	0.786
BOP% (F3)	21.8 ± 8.2	31.5 ± 10.3	<0.001 (A), 0.002 (B)	<0.001
Mean PPD (F0,mm)	3.24 ± 0.87	3.27 ± 0.89	-	0.791
Mean PPD (F3,mm)	2.85 ± 0.72	3.08 ± 0.80	0.004 (A), 0.018 (B)	0.031
Mean CAL (F0,mm)	3.58 ± 0.91	3.61 ± 0.95	-	0.813
Mean CAL (F3,mm)	3.50 ± 0.88	3.58 ± 0.93	0.023 (A), 0.046 (B)	0.048
Mean GR (F0,mm)	0.92 ± 0.51	0.93 ± 0.54	-	0.762

Mean GR (F3,mm)	0.94 ± 0.52	1.07 ± 0.59	0.091 (A), 0.013 (B)	0.041

TABLE 1 : F0 & F3 PERIODONTAL PARAMETERS

In table 1 we have found that, both the groups showed statistically significant improvements in PI, GI, BOP %, and PPD over 12 months after non-surgical periodontal therapy and standardized hygiene instructions, confirming that orthodontic treatment can be performed without worsening periodontal status. However, Group A (digitally guided) demonstrated greater reductions in plaque, gingival inflammation, and bleeding, suggesting that digital monitoring and 3D-guided planning promote better plaque control and milder gingival response.

OUTCOME	GROUP A	GROUP B	MEAN DIFFERENCE	P VALUE	COHEN'S D
PI	1.21 ± 0.32	1.47 ± 0.36	–0.26	<0.001	0.78
GI	1.10 ± 0.30	1.34 ± 0.35	–0.24	0.002	0.72
BOP%	21.8 ± 8.2	31.5 ± 10.3	–9.7	<0.001	1.01
PPD (mm)	2.85 ± 0.72	3.08 ± 0.80	–0.23	0.031	0.37
CAL (mm)	3.50 ± 0.88	3.58 ± 0.93	–0.08	0.048	0.29
GR (mm)	0.94 ± 0.52	1.07 ± 0.59	–0.13	0.041	0.34

TABLE 2 : BETWEEN GROUP & EFFECT SIZE COMPARISON AT 12 MONTHS

In table 2 we have found that, Digitally guided orthodontics (Group A) produced medium-to-large effect-size reductions in PI, GI, and BOP %, and small-to-moderate improvements in PPD, CAL, and gingival recession compared with conventional treatment (Group B). This indicates that digital workflows not only enhance gingival health but also help preserve periodontal support and minimize gingival stress in periodontally involved adults.

PARAMETER	GROUP A (F0-F3 Δ)	GROUP B (F0-F3 Δ)	P VALUE (A vs B)
PI (Δ)	–0.66 ± 0.25	–0.38 ± 0.28	<0.001
GI (Δ)	–0.60 ± 0.23	–0.34 ± 0.26	<0.001
BOP % (Δ)	–24.4 ± 7.6	–15.3 ± 8.2	<0.001
PPD (mm, Δ)	–0.39 ± 0.32	–0.19 ± 0.36	0.012
CAL (mm, Δ)	–0.08 ± 0.28	–0.03 ± 0.30	0.058
GR (mm, Δ)	0.02 ± 0.24	0.14 ± 0.27	0.039

TABLE 3 : INTRAGROUP CHANGE OVER TIME

In table 3 we have found that, group A demonstrated larger declines in PI, GI, BOP %, and PPD over 12 months, indicating stronger periodontal improvement under digitally guided care. The smaller change in CAL and less increase in gingival recession in Group A suggests that digital planning may help distribute orthodontic forces more evenly, protecting the periodontal apparatus in mild-to-moderate periodontitis patients.

GROUP	TOTAL SITES	PPD ≥mm (F0, %)	PPD ≥4 mm (F3, %)	Change % (F0–F3)	p-value (F0–F3)	p-value (A vs B at F3)
A	2700	28.4%	17.1%	–11.3 %	**<0.001**	**0.006**
B	2700	28.9%	22.6%	–6.3%	**0.009**	

TABLE 4 : DISTRIBUTION OF SITES WITH PPD ≥ 4MM AT F0 & 12 MONTHS

In table 4 we have found that, digitally guided orthodontics led to a greater reduction in deep-pocket sites (PPD ≥4 mm), with fewer residual deep pockets at 12 months compared with conventional treatment. This suggests that digital planning and structured monitoring help avoid aggressive tooth-positioning paths that might aggravate existing pockets, particularly in periodontally compromised adults.

OUTCOME	GROUP A	GROUP B	p-value (Mann-Whitney U)

	(Median [IQR])	Mean [IQR])	
DISCOMFORT (VAS 0-10)	2.0 [1.0–3.0]	3.5 [2.0–5.0]	0.004
DIFFICULTY MAINTAINING HYGIENE	2.0 [1.0–3.0]	4.0 [3.0–5.0]	<0.001
TREATMENT SATISFACTION	9.0 [8.0–10.0]	7.0 [6.0–8.0]	<0.001

TABLE 5 : PATIENT REPORTED OUTCOMES AT 12 MONTH (Median [IQR])

In table 5 we have found that, patients in Group A reported less discomfort, lower difficulty in oral-hygiene maintenance, and higher overall satisfaction than Group B, likely because digital workflows provided better-explained, gentler tooth-movement sequences and reinforced daily hygiene practices. This underscores that digitally guided orthodontics not only improves objective periodontal indices but also enhances subjective comfort and acceptance in periodontally involved adults in a Rajasthan-based clinical setting.

DISCUSSION

In our research, digitally guided orthodontics, when integrated with a periodontally aware protocol, leads to superior periodontal and patient-reported outcomes compared with conventional orthodontics in adults with mild-to-moderate periodontitis. In Table 1, the greater reductions in PI, GI, and BOP % at 12 months in Group A align with narrative and case-based data showing that digital-orthodontic setups and clear-aligner-based systems, when planned after periodontal stabilization, support gingival health and minimize plaque-related inflammation. This is further reinforced by work on digital workflows and 3D diagnostic planning, which emphasizes that careful virtual force-distribution and interdisciplinary coordination help avoid biomechanical stress at the gingival margin, thereby improving both clinical and subjective outcomes in periodontally involved adults.[7,8]

At the same time, Tables 2–4 show that digitally guided care was associated with smaller but statistically significant advantages in mean PPD, CAL, and gingival recession, as well as a greater reduction in sites with PPD ≥4 mm, which supports recent evidence that orthodontic treatment does not inherently worsen periodontitis when plaque control and biomechanics are optimized.[9,10]Moreover, in our study , intragroup showed a decline in deep-pocket sites in Group A (Table 4), which was consistent with the concept that digital-planning tools allow clinicians to avoid high-risk tooth-positioning moves (e.g., excessive incisor proclination), thereby preserving periodontal support and reducing the risk of recession. Finally, Table 5 demonstrates that digitally guided patients reported less discomfort, easier oral-hygiene maintenance, and higher satisfaction, echoing PDF-based studies on digital impressions and digital-orthodontic workflows that consistently report improved acceptability and comfort when patients receive digital-based monitoring and virtual previews of treatment.In contrast, some comparative studies of conventional versus digital model analysis note that accuracy itself may not differ markedly, but digital workflows confer time-saving, workflow optimization, and enhanced patient communication, which may indirectly bolster periodontal outcomes through better compliance and more precise, periodontally-sensitive planning.[11-13]Hence, our results suggest that digital-guidance in orthodontics not only preserves but may modestly improve periodontal status in mild-to-moderate periodontitis.

CONCLUSION

We come to conclude that, digitally guided orthodontics, when integrated with non-surgical periodontal therapy and standardized oral-hygiene instructions, leads to significantly better periodontal outcomes particularly in plaque control, gingival inflammation, and bleeding on probing compared with conventional orthodontic planning, while also showing modest advantages in probing pocket depth, clinical attachment level, and gingival recession. The digitally guided workflow, supported by intraoral scanning, 3D virtual diagnostic setup, and structured digital monitoring, appears to promote safer, more periodontally-friendly tooth movement and is associated with higher patient satisfaction and lower reported discomfort, suggesting that it is a suitable and advantageous approach for managing orthodontic treatment in adult patients with stage-I–III periodontitis.

REFERENCE

1. Sangalli L, Savoldi F, Dalessandri D, Bonetti S, Gu M, Signoroni A, Paganelli C. Effects of remote

digital monitoring on oral hygiene of orthodontic patients: a prospective study. BMC Oral Health. 2021 Sep 7;21(1):435.
2. Gehlot M, Sharma R, Tewari S, Kumar D, Gupta A. Effect of orthodontic treatment on periodontal health of periodontally compromised patients. Angle Orthod. 2022 May 1;92(3):324-332.
3. Ravera S, Castroflorio T, Mantovani E, Sedran A, Cugliari G, Deregibus A. Periodontal outcomes and digital data integration of orthodontic treatment with clear aligners: a prospective pilot study. Applied Sciences. 2023 Dec 22;14(1):116.
4. Kwon TH, Salem DM, Levin L. Periodontal considerations in orthodontic treatment: A review of the literature and recommended protocols. InSeminars in Orthodontics 2024 May 1 (Vol. 30, No. 2, pp. 80-88). WB Saunders.
5. Creagh J, Bohner L, Sesma N, Coachman C. Digital approaches to facially guided orthodontic and periodontal rehabilitation in the anterior esthetic zone: A case report. J Esthet Restor Dent. 2022 Jan;34(1):226-234.
6. Peikert SA, Mittelhamm F, Frisch E, Vach K, Ratka-Krüger P, Woelber JP. Use of digital periodontal data to compare periodontal treatment outcomes in a practice-based research network (PBRN): a proof of concept. BMC Oral Health. 2020 Oct 28;20(1):297.
7. Ronsivalle V, Malara C, Cicciù M, Venezia P, Lo Giudice A. Digital orthodontic setup and clear aligners system for treating adult patients with periodontitis: a descriptive case report. Front Dent Med. 2024 Feb 5;5:1353114.
8. Weber[1] AK, Berger T, Meier[1] LF, Keller CR, Schmid N. Digital Orthodontics Meets Periodontology: A Narrative Review of Data-Driven Risk Assessment Approaches.
9. Cuesta Román R, López-González ÁA, Obrador de Hevia J, Arroyo Bote S, Paublini Oliveira H, Riutord-Sbert P. Digitally Guided Modified Intentional Replantation for a Tooth with Hopeless Periodontal Prognosis: A Case Report. Diagnostics (Basel). 2025 Dec 3;15(23):3080.
10. Mangano A, Beretta M, Luongo G, Mangano C, Mangano F. Conventional Vs Digital Impressions: Acceptability, Treatment Comfort and Stress Among Young Orthodontic Patients. Open Dent J. 2018 Jan 31;12:118-124.
11. Bahammam HA. Conventional vs. digital impression: Comfort level, preferences, and acceptance of treatment time among orthodontic patients. The Open Dentistry Journal. 2022 Nov 1;16(1).
12. Garbo D, Baima G, Mariani GM, Romano F, Aimetti M. Orthodontic treatment in stage IV periodontitis patients: Timing, management and long-term prognosis. InSeminars in Orthodontics 2024 May 1 (Vol. 30, No. 2, pp. 113-122). WB Saunders.
13. Han JY. A comparative study of combined periodontal and orthodontic treatment with fixed appliances and clear aligners in patients with periodontitis. J Periodontal Implant Sci. 2015 Dec;45(6):193-204.