

DOI: <https://doi.org/10.56936/18290825-2026.20v.2->**AI-GUIDED PERSONALIZED DRUG-DELIVERY NANOPARTICLES FOR PRECISION TREATMENT OF PERI-IMPLANTITIS: A MULTICENTER EVALUATION****TUENKAR Y.A.<sup>1</sup>, SHANKARGOUDA S.<sup>2\*</sup>, SEHDEV B.<sup>3</sup>, SINGH R.B.<sup>4</sup>,  
RAMAMURTHY J.<sup>5</sup>, MAHAPATRA N.<sup>6</sup>**<sup>1</sup> Department Periodontics, Belagavi, KAHER's KLE Vishwanath Katti Institute of Dental Sciences Institute of dental sciences, Belagavi, Karnataka, India<sup>2</sup> Department of Prosthodontics & Crown and Bridge KAHER'S KLE Vishwanath Katti Institute of Dental Sciences Institute of Dental sciences, Belagavi Karnataka, India<sup>3</sup> Department of periodontology & implantology, RKDF Dental college, Bhopal, Madhya Pradesh, India<sup>4</sup> Department of Periodontology DAPM RV dental college Bengaluru, Karnataka, India<sup>5</sup> Department of Periodontics Saveetha Dental College and hospitals, Chennai Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, Tamil Nadu, India.<sup>6</sup> Department of Oral and Maxillofacial Pathology Kalinga Institute Of Dental Sciences, KIIT Deemed To be University, Patia, Bhubaneswar, Odisha, India*Received 12.12.2025; Accepted for printing 14.05.2026***ABSTRACT**

**Introduction:** Peri-implantitis is a pathological situation, which is characterized by inflammation of the peri-implant mucosa and gradual loss of supporting bone. Traditional methods, most often mechanical debridement are not effective enough to remove every bacteria biofilm on the rough titanium surfaces of the implants resulting in high recurrence rates. Nanotechnology can provide opportunities in targeted drug delivery, and artificial intelligence can allow personalizing the therapeutic regimen in relation to specific biomarkers of patients.

**Material and Methods:** 124 moderate-to-severe peri-implantitis patients were recruited in three dental clinics of the universities. The patients were randomly distributed into control group (mechanical debridement + Placebo gel) and test group (mechanical debridement + artificial intelligence -guided Nanoparticle gel). In the test group, the artificial intelligence algorithm has examined the predictors of peri-implant crevicular fluid biomarkers (IL-1 $\beta$ , MMP-8) and microbiological profiles in order to define the most suitable release kinetics and dose of minocycline-loaded nanoparticles. Clinical variables, which were probing pocket depth, bleeding on probing, and radiographic bone level, were measured at baseline, 3 months, and 6 months.

**Results:** Test group had a much more remarkable decrease in mean probing pocket depth as opposed to control group ( $2.8 \pm 0.6$  mm vs.  $1.4 \pm 0.5$  mm;  $p < 0.001$ ) at the 6-month follow-up. The bleeding on probing resolution percentage was 84.5 in the test group and 48.2 in the control group ( $p < 0.01$ ). Also, radiographic analysis indicated that the artificial intelligence -nanoparticle group showed a mean of  $0.88 \pm 0.29$  mm bone gain as opposed to the control group of  $0.16 \pm 0.10$  mm ( $p = 0.02$ ).

**Summary:** artificial intelligence -directed personalization with nanoparticle delivery of drugs was able to promote better clinical outcomes in peri-implantitis therapy as compared to mechanical debridement alone. This is a promising avenue of treating complicated infections around the implant through this precision medicine method.

**KEYWORDS:** peri-implantitis, artificial intelligence, nanoparticles, drug delivery, precision medicine, minocycline**CITE THIS ARTICLE AS:**

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