ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7328-7332 (2026)
©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences
BIOMEDICAL INFORMATICS
www.bioinformation.net
Volume 22(10)
Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026
DOI: 10.6026/973206300227328

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Ashwini Dhopte
E-mail: ashwinidhopte@gmail.com
Citation: Babu *et al*. Bioinformation 22(10): 7328-7332 (2026)

Dental implant hemocompatibility: Comparison of two surface treatments

Shyju Prasad Suresh Babu[1], Giri Chandramohan[2], Aparna Mohan[2,*], Junu Henry[2], Allen Jim Hines[2] & Celin Joel Chelladhurai[2]

[1]Department of Prosthodontics and Crown & Bridge, Thampy's S.P. Dental Clinic, Nagercoil, Kanyakumari, Tamil Nadu, India; [2]Department of Prosthodontics, Sree Mookambika Institute of Dental Sciences, Kulasekharam, Tamil Nadu, India; *Corresponding author

Affiliation URL:
https://sreemookambika.edu.in/smids

Author contact:
Shyju Prasad Suresh Babu - E-mail: drshyjuprasad@gmail.com

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7328-7332 (2026)
©Biomedical Informatics (2026)

Giri Chandramohan - E-mail: giritc@yahoo.com
Aparna Mohan - E-mail: aparraj1972@gmail.com
Junu Henry - E-mail: junujubin@gmail.com
Allen Jim Hines - E-mail: hinesjimallen@gmail.com
Celin Joel Chelladhurai - E-mail: joeldhurai@gmail.com

Abstract:
Implant surface topography can influence the initial blood-surface interaction that precedes osseointegration. Therefore, it is of interest to compare the hemocompatibility of 14 commercially available titanium implants with calcium-phosphate-blasted surfaces (Group I, n=7) or alumina-blasted and acid-etched surfaces (Group II, n=7) using blood-cell counts, platelet measures and platelet adhesion/activation assays. Initial-to-final paired comparisons were not statistically significant in either group (Group I p=0.551; Group II p=0.488), while platelet adhesion/activation was numerically higher for the calcium-phosphate-blasted surface (409.94±884.62 vs 352.79±723.63 IU/L). The reported hemolysis values are unusually high for conventional hemocompatibility interpretation and should be verified against the original laboratory calculation and units before submission. Thus, surface-dependent variation in early blood interactions, but the present results do not establish statistically significant superiority of one surface treatment.

Keywords: Hemocompatibility, dental implant surface treatments, platelet adhesion and activation

Background:
Dental implants are widely used to restore partial and complete edentulism and long-term success depends on stable osseointegration at the bone-implant interface **[1]**. Immediately after placement, blood contacts the implant surface and a fibrin-rich clot forms, creating the provisional matrix for cell attachment and subsequent bone healing **[2]**. Surface chemistry, roughness, wettability and micro/nanotopography can influence protein adsorption and the adhesion and activation of platelets and other blood cells **[2, 3]**. Common surface-modification strategies include grit blasting, acid etching, anodization, calcium-phosphate treatment, plasma spraying, laser modification and biomimetic coatings. Contemporary experimental evidence confirms that titanium surface topography can modulate initial platelet adhesion, although adhesion and platelet-granule secretion may not change in parallel **[4-7]**. Platelet-mediated signaling is also biologically relevant to early osseointegration and is the focus of ongoing implant research **[8]**. Therefore, it is of interest to compare the hemocompatibility of calcium-phosphate-blasted (Osseofix) and alumina-blasted/acid-etched (Touareg S) dental implant surfaces.

Materials and Methods:
This *in vitro* study was conducted in the Department of Prosthodontics using 14 Adin titanium dental implants (3.5 mm diameter, 11.5 mm length) with two surface treatments. The implants were divided into Group I (n=7), calcium-phosphate-blasted Osseofix surfaces and Group II (n=7), alumina-blasted and acid-etched Touareg S surfaces (Adin Dental Implant Systems, Israel). Whole blood from the research scholar was used to evaluate early cellular interactions. Implants were exposed to blood in sterile polystyrene tubes under agitation (75±5 rpm) at the reported test temperature; samples were analysed at 10 and 30 minutes for the reported hemolysis, total-cell-count and platelet-count variables using an automated hematology analyser (Sysmex K-4500, Sysmex Corporation, Kobe, Japan). Platelet-rich plasma was prepared by centrifugation and used for the platelet adhesion/activation assay, with lactate dehydrogenase activity measured after exposure. The implants were then rinsed, fixed, dehydrated through graded ethanol, dried and examined by scanning electron microscopy to visualize adherent platelets. Because the reported percentage-hemolysis values were atypically high for conventional hemocompatibility interpretation, these source-reported values were interpreted conservatively and require confirmation against the original laboratory calculation method and units.

Results:
Table 1 presents the mean percentage hemolysis values for Group I and Group II at initial and final assessments. In Group I, mean hemolysis increased from 84.23 ± 3.85% initially to 86.39 ± 3.82% at the final assessment, representing an increase of 2.16 percentage points. Conversely, Group II demonstrated a reduction from 82.76 ± 2.26% to 81.74 ± 5.87%, corresponding to a decrease of 1.02 percentage points. At the final assessment, Group I exhibited numerically higher hemolysis than Group II, with a difference of 4.65 percentage points. These findings indicated contrasting numerical trends between the implant surfaces. However, statistical significance for these specific comparisons was not provided and the unusually high reported hemolysis percentages require verification before drawing conclusions regarding hemocompatibility. **Table 2** shows changes in mean total cell counts between initial and final assessments. Group I showed an increase from 6816.73 ± 6.99 to 8400.00 ± 1.92 cells/mm³, representing an increase of 1583.27 cells/mm³. Similarly, Group II demonstrated an increase from 6566.70 ± 1.30 to 8350.00 ± 1.30 cells/mm³, corresponding to an increase of 1783.30 cells/mm³. Although Group II demonstrated a greater absolute increase, the final total cell count remained slightly higher in Group I. These findings indicated numerical increases in total cell counts in both groups, without establishing a statistically significant difference between implant surfaces.

Table 3 presents the initial and final platelet counts in both groups. Group I demonstrated a slight increase from 26.35 ± 4.65 to 26.68 ± 7.90, representing a mean increase of 0.33 in the reported units. Group II showed an increase from 25.81 ± 7.62 to 26.60 ± 4.83, corresponding to a mean increase of 0.79. The final platelet counts were nearly comparable between groups, with a numerical difference of only 0.08. These findings suggested relatively small changes in platelet counts following exposure to the respective implant surfaces. However, the measurement units and statistical significance require confirmation. **Table 4** compares mean platelet adhesion and activation between the two implant surfaces. Group I demonstrated a higher mean value of 409.94 ± 884.62 IU/L compared with 352.79 ± 723.63 IU/L in Group II, representing an absolute difference of 57.15 IU/L. Although platelet adhesion and activation were numerically higher in Group I, both groups exhibited substantial variability, as indicated by standard deviations exceeding their respective means. These findings suggested considerable dispersion in platelet responses. Without a reported between-group statistical test, the observed numerical difference could not be considered statistically significant or evidence of superior hemocompatibility. **Table 5** presents paired statistical comparisons of initial and final measurements within both groups. Group I demonstrated a mean paired difference of 1.02 ± 3.91, with a standard error of 1.60 and a 95% confidence interval ranging from −3.09 to 5.13. The paired t-test revealed no statistically significant difference (t = 0.639, df = 5, p = 0.551). Similarly, Group II demonstrated a mean paired difference of −2.16 ± 7.07, with a standard error of 2.88 and a 95% confidence interval extending from −9.57 to 5.26. This comparison was also statistically nonsignificant (t = −0.748, df = 5, p = 0.488). Both confidence intervals included zero, supporting the absence of statistically significant paired changes. Overall, the reported analyses did not establish significant initial-to-final differences within either group.

Table 1: Mean percentage hemolysis of group i and group ii

Groups	% of hemolysis (MEAN±SD)
Group-I INITIAL	84.23±3.85
Group-I FINAL	86.39±3.82
Group-II INITIAL	82.76±2.26
Group-II FINAL	81.74±5.87

Table 2: Comparison of mean total count between the groups

Groups	Total count (Cell/cubic mm) (MEAN±SD)
Group-I initial	6816.73±6.99
Group-I final	8400.00±1.92
Group-II initial	6566.70±1.30
Group-II final	8350.00±1.30

Table 3: Comparison of mean platelets between the groups

Groups	Platelets(Cells/cubic mm) (MEAN±SD)
Group-I initial	26.35±4.65
Group-I final	26.68±7.90
Group-II initial	25.81±7.62
Group-II final	26.60±4.83

Table 4: Comparison of mean platelet adhesion and activation between the groups

Groups	Platelet adhesion and activation (IU/L) (MEAN±SD)
Group-I	409.94±884.62
Group-II	352.79±723.63

Table 5: Comparison of initial & final values of group i & group ii

	VAR00001				Paired Differences					T	Df	P value
					Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
								Lower	Upper			
1	GP 1	INITIAL VALUES	&	FINAL	1.02	3.91222	1.59716	-3.08562	5.12562	0.639	5	0.551
2	GP2	INITIAL VALUES	&	FINAL	-2.15667	7.066	2.88468	-9.57198	5.25865	-0.748	5	0.488

Discussion:

Surface modification influences the earliest biological events after implant placement because blood proteins, platelets and the developing fibrin network contact the implant before osteogenic cells reach the surface. Surface chemistry, roughness and wettability can modify protein adsorption and cell attachment and contemporary experimental evidence confirms that implant micro- and nanotopography can alter platelet adhesion and other blood-surface interactions **[9-13]**. Calcium-phosphate blasting and alumina blasting followed by acid etching create different chemical and topographic environments, making comparison of their initial blood interactions biologically relevant **[14-18].** The present study used commercially available screw-type implants rather than flat titanium discs, which better preserves clinically relevant macrogeometry; however, this remains an *in vitro* model and early blood compatibility cannot by itself establish the rate or quality of subsequent osseointegration. Platelet adhesion and activation are potentially relevant to clot organization and early healing, but osseointegration is a multistage process involving immune, vascular and osteogenic responses **[19, 20]**. Accordingly, the present findings should be interpreted as measurements of early blood-implant interaction rather than direct evidence of superior bone integration. Fourteen implants were evaluated, with seven calcium-phosphate-blasted implants in Group I and seven alumina-blasted/acid-etched implants in Group II. The manuscript reports percentage hemolysis values of 84.23±3.85 initially and 86.39 ± 3.82 finally in Group I, compared with 82.76 ± 2.26 and 81.74 ± 5.87 in Group II. These values are unusually high if they represent conventional percentage hemolysis and should therefore be checked against the original calculation method, units, positive/negative controls and laboratory worksheet before publication. For platelet counts and total cell counts, the manuscript reports numerical changes over time, but the paired comparisons were not statistically significant (Group I p=0.551; Group II p=0.488). Mean platelet adhesion/activation

measured by the reported lactate-dehydrogenase assay was also numerically higher for Group I (409.94 ± 884.62 IU/L) than Group II (352.79 ± 723.63 IU/L); the very large dispersion and absence of a valid significant between-group test preclude a claim of superiority. Earlier studies have shown that titanium surface properties can influence platelet behaviour and clot organization but different assays, implant geometries and surface treatments limit direct quantitative comparison. The current experiment therefore supports the presence of surface-dependent numerical variation, while confirmation in a larger, adequately powered study with validated hemolysis methodology and prespecified between-group statistics is needed before concluding that one treatment is more hemocompatible or produces faster osseointegration. Recent 2026 reviews likewise emphasize that implant-surface chemistry, topography, wettability, antimicrobial behavior and osteoimmunomodulatory properties jointly influence early biological interactions and the subsequent osseointegration environment **[21, 22].** Rajan *et al.* **[23]** compared polished and sandblasted, acid-etched titanium and zirconia specimens in an in vitro hemocompatibility experiment. They reported that polished titanium showed the most favorable hemocompatibility outcomes under their experimental conditions, even though surface treatment increased roughness. Their study is particularly relevant because it evaluated blood-related responses to implant biomaterials, but differences in specimen material, surface preparation, assay conditions and measured outcomes prevent a direct quantitative comparison with the two commercially manufactured titanium implant surfaces investigated here. Thus, the present numerically higher platelet adhesion/activation in Group I cannot be equated with superior overall hemocompatibility. In a narrative synthesis of implant surface modifications, Dhruve *et al.* **[24]** reviewed calcium-phosphate-based resorbable blast media and sandblasted, acid-etched surface technologies and highlighted the difficulty of establishing the long-term superiority of any single treatment. Sehrawat *et al.* **[25]** likewise summarized conventional implant surface modifications and their relevance to osseointegration, providing a rationale for investigating distinct blasting and etching protocols. In an experimental study on Ti-6Al-4V alloy, Hsiao *et al.* **[26]** found that combined mechanical and chemical modifications influenced surface characteristics and subsequent cell attachment. However, that work focused on surface characterization and osteoblast-related cellular outcomes rather than blood-contact assays; its findings therefore support a surface-specific biological response, not an inference of statistically significant differences in hemolysis or platelet activation in the present study. The clinical relevance of early platelet behavior also needs to be distinguished from the effects of processed platelet concentrates. Shirbhate and Bajaj **[27]** reviewed third-generation platelet concentrates in periodontal regeneration, discussing their fibrin architecture and release of growth-factor-related mediators. This literature provides biological context for the importance of platelets during tissue repair but does not directly assess the hemocompatibility of calcium-phosphate-blasted versus alumina-blasted/acid-etched implants.

Conclusion:
Calcium-phosphate-blasted and alumina-blasted/acid-etched implant surfaces showed different numerical patterns of early blood interaction in this *in vitro* model. The calcium-phosphate-blasted surface had higher mean platelet adhesion/activation, but the presented inferential statistics do not show statistically significant superiority. Verification of the hemolysis calculation and appropriately powered between-group testing are required before making claims of enhanced or accelerated osseointegration.

Financial support and sponsorship: Nil.

Conflicts of interest:
The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

Ethical approval:
Ethical approval of the study was obtained from the ethical committee.

Registration Number:
This study was approved by the ethical committee of Sree Mookambika Institute of Dental Sciences with registration number SMIMS/IHEC NO: 1/PROTOCOL NO: 12/2021

Acknowledgement:
This study was derived from a Dissertation for a master's degree in Prosthodontics. The authors would like to thank the co-operation of faculties in the Department of Prosthodontics of Sree Mookambika Institute of Dental Sciences.

References:
[1] Wennerberg A & Albrektsson T. *Int J Oral Maxillofac Implants*. 2010 **25:**63 [PMID: 20209188]
[2] Albrektsson T & Wennerberg A. *Clin Implant Dent Relat Res.* 2019 **21:**4. [PMID: 30816639]
[3] Tamada Y *et al. Biomaterials.* 1995 **16:**259. [PMID: 7749004]
[4] Milleret V *et al. Eur Cell Mater.* 2011 **21:**430. [PMID: 21604243]
[5] Kopf BS *et al. J Biomed Mater Res A*. 2015 **103:**2661. [PMID: 25631679]
[6] Albrektsson T & Wennerberg A. *Int J Prosthodont.* 2004 **17:**544 [PMID: 15543911]
[7] Sun Y *et al. J Mater Sci Mater Med.* 2024 **35**:52 [PMID: 39177838]
[8] Park JY & Davies J E *Clin Oral Implants Res*. 2000 **11:**530. [PMID: 11168246]
[9] Bhavan Chand Y *et al. Int J Prosthodont Restor Dent.* 2012 **2:**136. [DOI: 10.5005/jp-journals-10019-1062]
[10] Hoffmann W *et al. J Tissue Eng*. 2014 **5**:2041731414540674. [PMID: 25383165]

[11] Ye SH *et al. Colloids Surf B Biointerfaces.* 2009 **74**:96. [PMID: 19647420]
[12] Liu R *et al. J Prosthodont.* 2013 **22:**641. [PMID: 23725293]
[13] Nakamura M *et al. Int J Implant Dent.* 2020 **6:**74. [PMID: 33215329]
[14] Habijan T *et al. Mater Sci Eng C Mater Biol Appl*. 2013 **33**:419. [PMID: 25428090]
[15] Hou PJ *et al. Appl Sci.* 2020 **10:**8582. [DOI: 10.3390/app10238582]
[16] Manivasagam VK *et al. Mater Adv*. 2021 **2:**5824. [PMID: 34671743]
[17] Zhang H *et al. Front Bioeng Biotechnol*. 2025 **13:**1549439. [PMID: 40177619]
[18] Verma K *et al. Saudi J Oral Dent Res.* 2025 **10:**241. [DOI: 10.36348/sjodr.2025.v10i05.003]
[19] Guo CY *et al. J Oral Biol Craniofac Res.* 2024 **14:**471. [PMID: 38962718]
[20] Ivanovski S *et al. Periodontol 2000.* 2025 **97:**271. [PMID: 38647020]
[21] Jadhav L *et al. J Mater Sci Mater Med*. 2026 **37**:21. [PMID: 41519933]
[22] Shurbaji S *et al. Front Bioeng Biotechnol*. 2026 **14**:1795260. [PMID: 42238481]
[23] Rajan A *et al. J Contemp Dent Pract*. 2018 **19**:1448. [PMID: 30713172]
[24] Dhruve N *et al. Int J Sci Res Technol.* 2026 **3**:1152. [DOI: 10.5281/zenodo.21703251]
[25] Sehrawat M *et al. IP Ann Prosthodont Restor Dent.* 2021 **7**:64. [DOI: 10.18231/j.aprd.2021.013]
[26] Hsiao VKS *et al. Appl Sci.* 2024 **14**:10904. [DOI: 10.3390/app142310904]
[27] Shirbhate U & Bajaj P. *Cureus.* 2022 **14**:e28072. [PMID: 36127983]

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.