

Introduction

Surface wettability plays a critical role in the early stages of implant integration, influencing protein adsorption, cell adhesion, and tissue healing. While titanium and titanium alloys are widely used in dental implants, the impact of different surgical irrigation solutions on their surface hydrophilicity remains unclear. Continuous irrigation during implant placement is essential to reduce heat generation and prevent thermal bone injury, and because irrigants are among the first fluids to contact the implant surface, they may also influence surface hydrophilicity. Understanding how irrigants affect wettability may guide clinical decision making to optimize implant–tissue interactions.

Objective

To compare the effects of 0.9% sodium chloride (NaCl), sterile water, and distilled water on the wettability of commercially pure titanium (Grade 4)- and Ti-6Al-4V-alloy (Grade 5) implant surfaces.

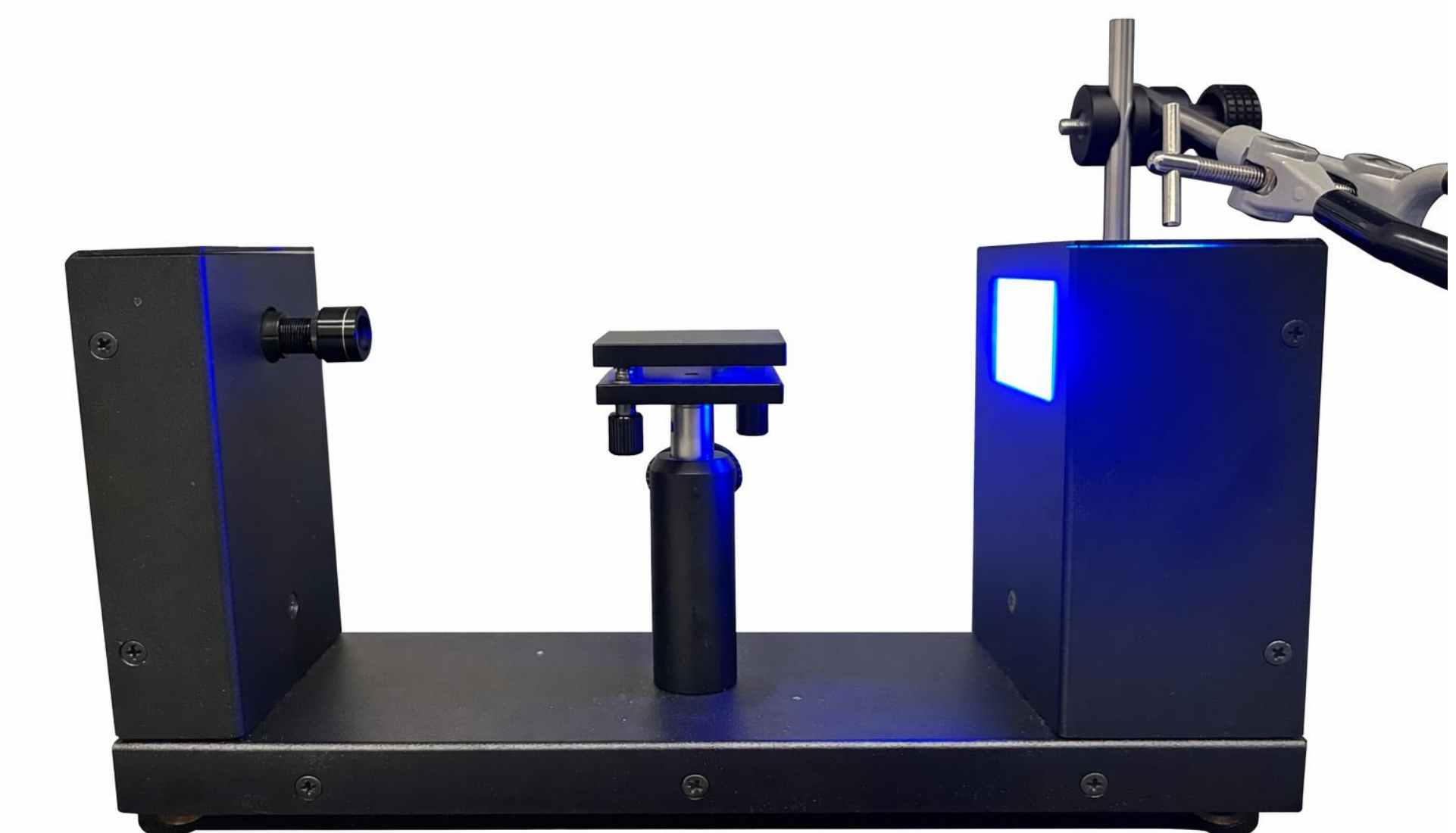
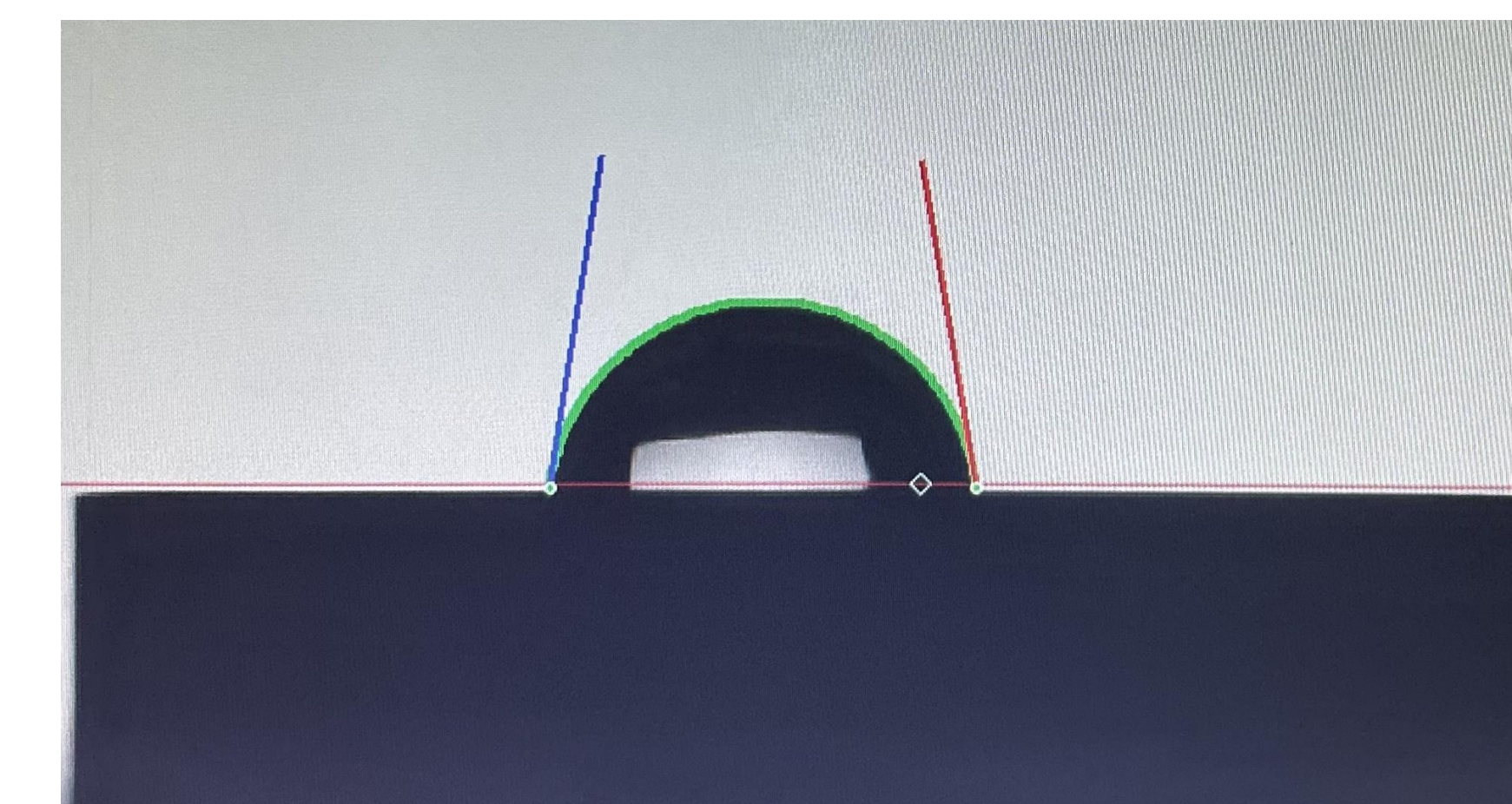
Materials

This in vitro study was conducted to evaluate and compare the wettability of Titanium Grade 4 (pure Ti) and Titanium Grade 5 (Ti-6Al-4V alloy) of dental implant surfaces after exposure to three used clinical irrigation fluids:

- 0.9% Sodium Chloride (NaCl)
- Sterile Water
- Distilled Water

Methods

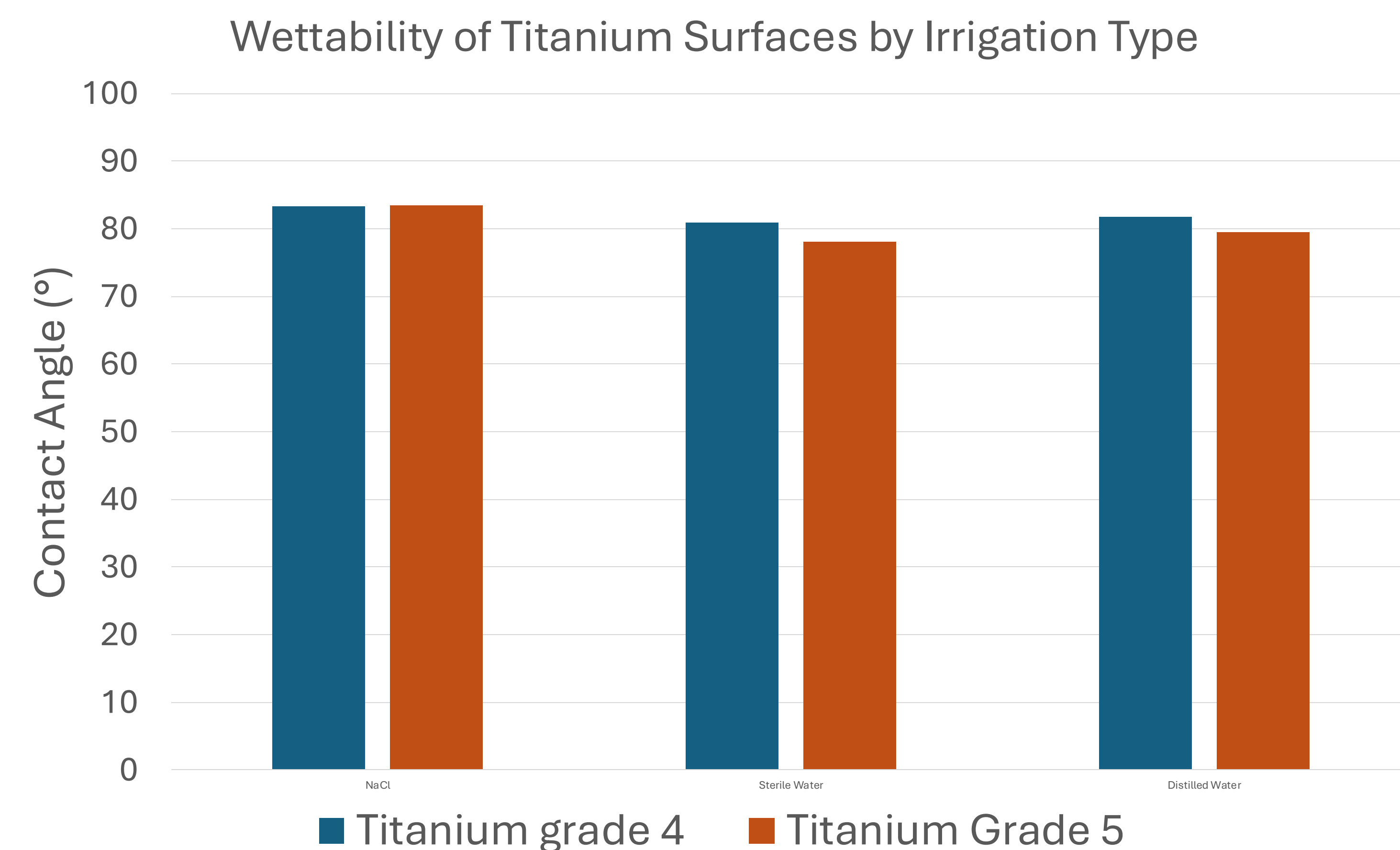
Wettability was evaluated via sessile drop contact angle measurements using an Ossila[®] goniometer, with lower angles indicating greater hydrophilicity (wettability). Data were analyzed with one-way ANOVA and post hoc Bonferroni-testing ($p < 0.05$).



Results

No significant differences in contact angle were observed among the irrigants on pure titanium surfaces (all $p > 0.05$). In contrast, on Ti-6Al-4V alloy surfaces, NaCl resulted in significantly higher contact angles compared to sterile water, indicating reduced wettability ($p = 0.004$). No significant differences were found between distilled water and either sterile water or NaCl.

Irrigant Used	Titanium Grade 4 (°)	Titanium Grade 5 (°)
NaCl	83.38°±5.48	83.52°±6.22
Sterile Water	80.90°±5.95	78.07°±5.23
Distilled Water	81.71°±4.85	79.55°±3.87



Discussion

- Increased implant surface hydrophilicity, reflected by lower contact angles, is associated with improved protein adsorption, fibrin attachment, and early cell adhesion, all of which support osseointegration.
- During implant surgery, irrigation is essential for heat control, prevention of thermal bone injury, and removal of bone debris and contaminants.
- Beyond temperature control, irrigation is the first liquid to directly contact the implant surface at placement, making this early surface–liquid interaction clinically relevant.
- Despite its universal use, irrigation has traditionally been viewed as a supportive surgical step, with limited focus on its potential effects on implant surface behavior.
- Consequently, the ability of different irrigation solutions to influence implant wettability and hydrophilicity remains underexplored.
- This study helps address this gap by demonstrating material-dependent effects of irrigation on titanium implant wettability, particularly on Grade 4 and Grade 5 Titanium.

Discussion

- Irrigation effects on titanium implant wettability were material-dependent, differing between Grade 4 and Grade 5 titanium.
- Grade 4 titanium showed no significant differences in contact angle across NaCl, sterile water, or distilled water.
- In contrast, Grade 5 titanium was sensitive to irrigation type, with NaCl significantly reducing wettability compared to sterile water ($p = 0.004$).
- Clinically, sterile water may be preferable for Ti-6Al-4V implants, as improved wettability has been associated with enhanced early healing.
- Several limitations should be considered, including the in vitro design, which does not fully replicate the biological conditions present in vivo, as well as the assessment of wettability alone without evaluation of cellular response or long-term osseointegration.
- Further studies incorporating biological models and clinical outcomes are needed to determine whether these wettability differences translate into meaningful improvements in implant stability and long-term success.

Conclusion

Within the limitations of this in vitro study, irrigation demonstrated material-dependent effects on titanium implant wettability. Ti-6Al-4V (Grade 5) showed reduced wettability with NaCl compared to sterile water, while Grade 4 titanium was unaffected, highlighting irrigation as a clinically relevant factor beyond thermal control and warranting further biologic and clinical investigation.

References

- Gittens, Rolando A., et al. "A Review on the Wettability of Dental Implant Surfaces II: Biological and Clinical Aspects." *Acta Biomaterialia*, vol. 10, no. 7, July 2014, pp. 2907–2918.
- Rupp, Frank, et al. "A Review on the Wettability of Dental Implant Surfaces I: Theoretical and Experimental Aspects." *Acta Biomaterialia*, vol. 10, no. 7, July 2014, pp. 2894–2906.