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Reduced friction in silk suture threads via atmospheric-pressure plasma-polymerization of coatings

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The surgical sutures sector is in continuous growth. According to the Global Surgical Sutures Market, it reached $4.3 billion in 2022 and is expected to exceed $6.9 billion by 2030; representing more than half of the global surgical devices market [1]. Optimal wound healing requires good blood supply, good mechanical strength, good knot security, minimum tension that minimizes tissue reactions and does not cause infections or allergic reactions [2]. In the last decades, a great diversity of materials (both natural and synthetic), such as silk, nylon, polyglycolic acid (PGA), polycaprolactone (PCL), polypropylene (PP) and polyethylene (PET), has been used to manufacture suture threads.
Silk is one of the most widely used suture materials because of its ease of use, biocompatibility, wide applicability in surgery (gastrointestinal, ocular, cardiovascular, ophthalmology and plastic surgery), low price, satisfactory mechanical properties and good knot security. However, silk generates more friction than other materials, increasing the patient's discomfort, pain and inflammatory reaction, impairing healing and causing a greater degree of tissue damage [3]. So, silk threads are usually coated with wax, silicone, chitosan, polyglactin, calcium stearate, polybutylene, silver nanoparticles and antimicrobial peptides through dip coating, layer-by-layer deposition or grafting. However, the investigations that have been reported were mainly aimed at producing anti-bacterial and anti-inflammatory materials. The frictional behavior of suture threads has rarely been investigated [4].
Recently, low-pressure plasma devices have been used to activate the surface of the threads before the processes of dipping into the coating solutions and drying. The main drawbacks of all these methods are the long time (30min) and high temperature (100ºC) that are required to dry the sutures in an oven, along with the possibility that the coatings come off during the suturing practice [5,6].
In this study, atmospheric-pressure plasma-polymerized coatings based on amino-silane liquid precursors were deposited on silk suture threads. The use of atmospheric-pressure equipment eliminates the need to incorporate vacuum chambers in the process, thus facilitating industrial scalability and decreasing manufacturing costs. Another advantage is that the process is carried out at room temperature and the polymerization takes place in less than 2 minutes.
For that purpose, we developed a device that passed the thread through an area that was exposed to plasma. Once plasma-polymerization was completed, the suture was ready for use. To analyze the frictional forces experienced between the skin and the thread, coated and uncoated (control) suture threads were passed through pork samples several times. The frictional forces acting on the tissue were measured using a load cell.
SEM and EDS analyses were applied to verify the durability and stability of the coatings during the suturing process. Despite slightly increasing the surface roughness, the deposited coatings increased the hydrophilicity of the silk; which finally had a positive influence on the reduction of the frictional forces that were generated between the thread and the tissue. The results showed the potential application of atmospheric-pressure plasma-polymerized coatings for the wound suturing industry.

References

[1] McKinsey & Well Company, *Life Science*, July, 195 (2023).
[2] M.R. Arjun et al., *Journal of Dental Science Research & Reports*, 6(1), 1-5 (2024).
[3] A. Faris et al., *International Dental Journal*, 72(3), 278-287 (2022).
[4] Y. Li et al., *Acta Biomaterialia*, 15:168, 78-112 (2023).
[5] N. Bhouri et al., *Journal of Industrial Textiles*, 51(4S), 6353-6376 (2021).
[6] G. Zhang et al., Friction, 8, 58-69 (2020).