Identification of collagen-containing gel in the composition of mesh endoprostheses using Raman spectroscopy

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INTRODUCTION

Synthetic mesh prostheses are standard in abdominal and pelvic wall reconstruction, valued for their mechanical strength and ability to reduce disease recurrence. However, their use is hampered by poor biointegration, which triggers a chronic foreign body response. This reaction, characterized by giant cells and inflammation, can lead to fibrosis, pain, and implant failure.

-Biointegration

- Reduced Foreign Body Reaction

MATERIALS AND METHODS OF RESEARCH

The study used 1x1 cm mesh endoprostheses by Lintex LLC, coated with a collagen gel.

The sample groups were:

Group 1: "Aslan" mesh with gel

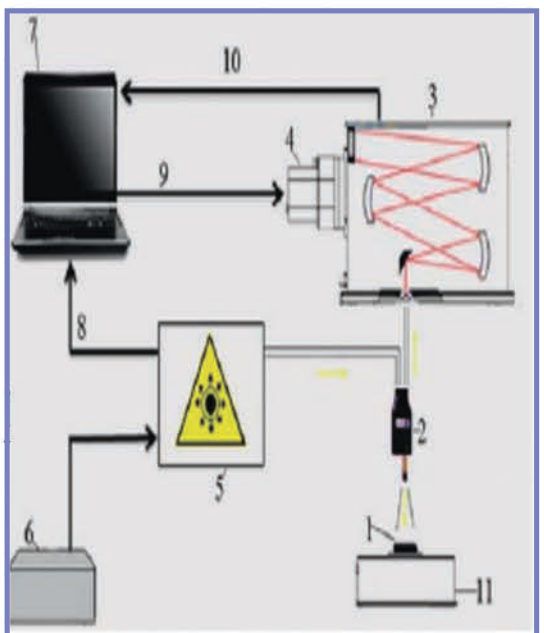
Group 2: "Aslan" mesh without gel

Group 3: "Uniflex" mesh with gel

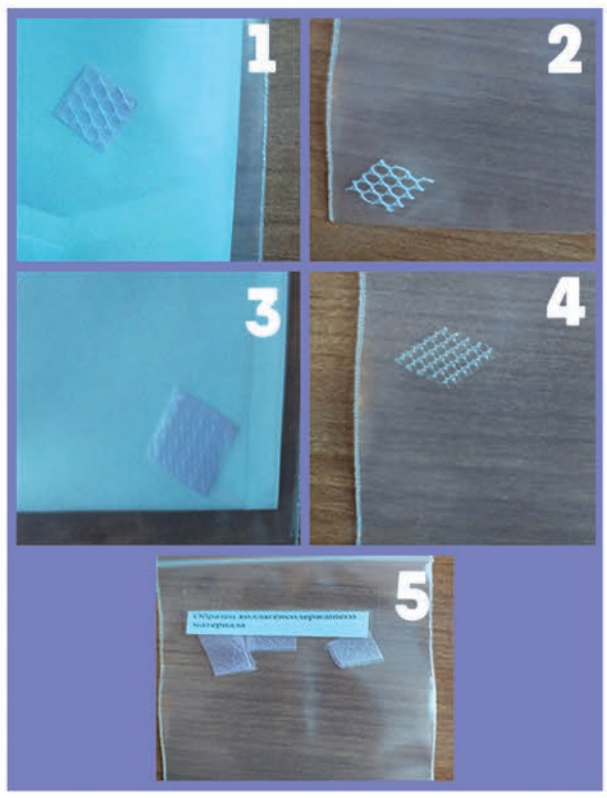
Group 4: "Uniflex" mesh without gel

Group 5: Collagen gel alone

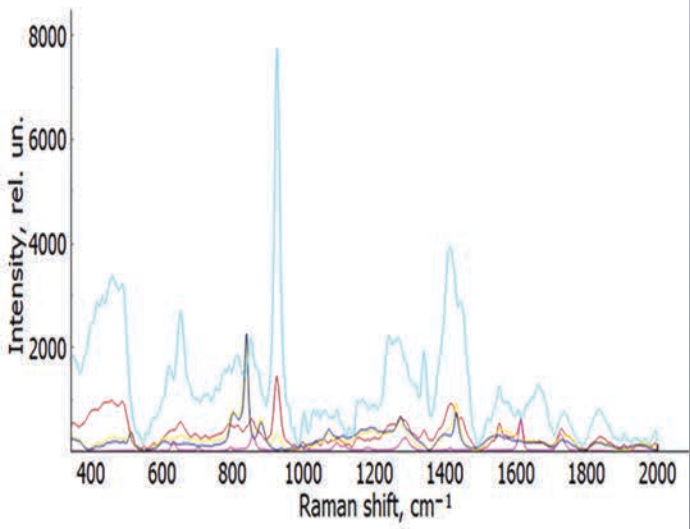
The in vitro analysis was performed using Raman spectroscopy. The setup consisted of a semiconductor laser (LML-785.0RB-04), a Raman scattering module (PBL 785), a spectrograph (Sharmrock SR-303i), and a cooled digital camera (ANDORDV-420A-OE, -60°C) connected to a computer.



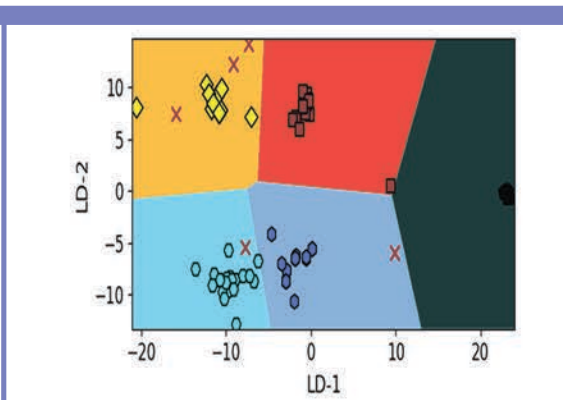
Experimental bench. 1 — sample, 2 — RPB785 Raman probe, 3 — Shamrock SR-303i spectrometer, 4 — DV420A-OE optical detector, 5 — Luxx Master Raman Boxx 785.0RB-04 laser source, 6 — laser power supply, 7 — computer, 8, 9, 10 — control cables, 11 — coordinate table.



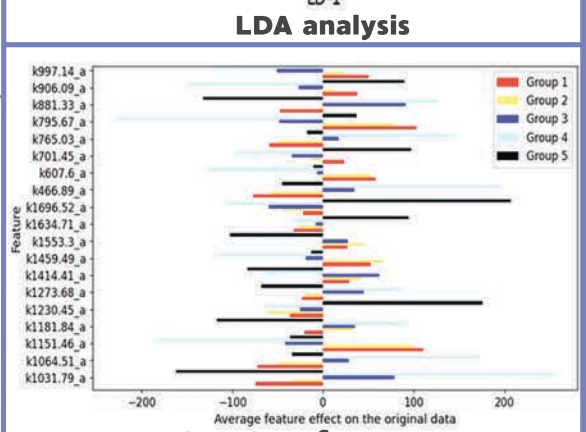
RESULTS OF RESEARCH



Red line – "Aslan" mesh with gel
Yellow line – "Aslan mesh without gel
Blue line – "Uniflex" mesh with gel
Black line – "Uniflex" mesh without gel
Light blue line – Collagen gel alone



LDA analysis



Metric values for each group

CONCLUSION

The study identified specific Raman spectral bands confirming the presence of collagen gel on and within the pores of Lintex's "Aslan" and "Uniflex" mesh endoprostheses. Key collagen bands were detected at: 660 cm^{1} (C-S stretching of cystine), 924 cm^{1} (C-C, proline ring), 1338 cm^{1} (CH_3CH_2 wagging)

The results demonstrate that Raman spectroscopy is a reliable method for identifying the lyophilized collagen hydrogel on the mesh implants. It was experimentally confirmed that the lyophilization and sterilization processes do not cause significant changes to the hydrogel's chemical composition or supramolecular structure, confirming its stability and suitability for biomedical use.