Enhanced Anti-migration Performance of Adhesive Stents via Nanostructure Interlocking Interfaces

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Non-vascular stents, such as those for the esophagus and biliary tract, often suffer from migration due to mechanical mismatch between the device and surrounding tissue. While conventional fixation methods-including clips, hooks, or sutures-are widely used, they can cause adverse effects such as tissue perforation, inflammation, or infection. Hydrogels, with their soft and moist nature, are ideal for tissue interfaces but exhibit poor adhesion to rigid, dry metal surfaces. To overcome this challenge, we developed a nanostructured interlocking interface-termed robust interlocking nano connector (RINC)-by fabricating a porous silica nanofilm on stents. When coated with hydrogel, this hydrogel-impregnated RINC (HiRINC) enables strong and durable bonding through synergistic mechanical interlocking and increased bonding sites. HiRINC stents demonstrated minimal swelling, improved adhesion, and enhanced mechanical stability. In both in vivo and ex vivo rat esophagus models, HiRINC significantly outperformed conventional stents by preventing migration for over four weeks, whereas controls migrated within two weeks. This interfacial design mitigates the mechanical mismatch between stent and tissue, offering a promising platform for next-generation anti-migration stents applicable across various non-vascular luminal systems.

References

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Figures

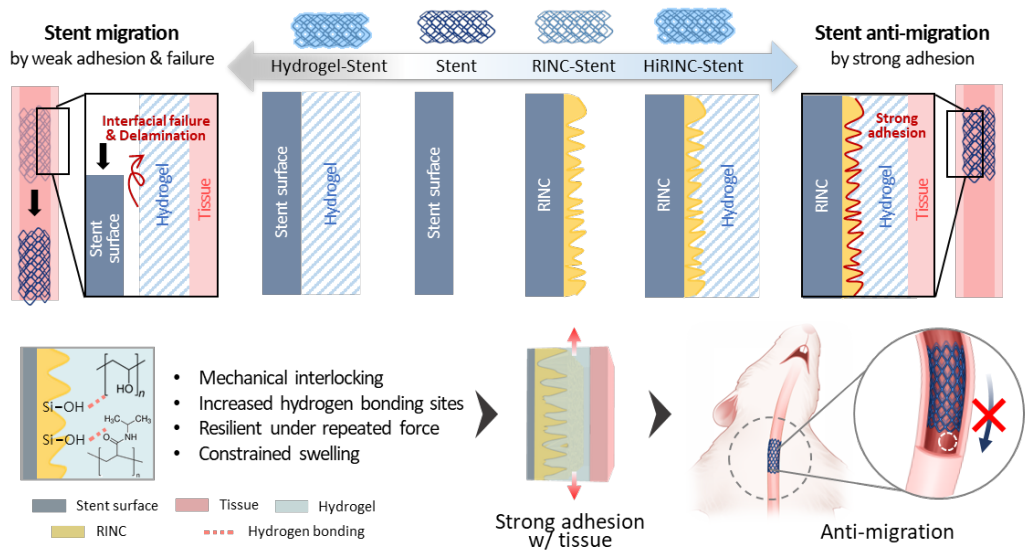

Figure 1: Schematic illustration of weak adhesion in conventional stents and the enhanced tissue-stent bonding achieved by HiRINC. The hydrogel-impregnated nano-interlocking structure strengthens interfacial adhesion, effectively preventing stent migration in esophagus.