# Hydrogel for treating pediatric tracheomalacia

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Tracheomalacia (TM) is a life-threatening condition in infants characterized by weakened tracheal cartilage that causes airway collapse, respiratory failure, and an elevated risk of cardiopulmonary arrest. Current management of severe TM typically involves invasive procedures such as tracheal reconstruction, pexy, tracheostomy, or stenting. While effective, these interventions are technically complex and carry substantial risks of complications. Hydrogel adhesives present a compelling non-invasive alternative, offering biocompatible flexibility and the ability to provide extraluminal mechanical support that mimics the natural dynamics of the trachea.

A primary challenge for conventional hydrogels is maintaining a secure bond under the constant motion of breathing. To overcome this, we engineered fatigue-resistant adhesives by leveraging dense polymer chain entanglements achieved through solvent-free polymerization with a low crosslinker-to-monomer ratio. Mechanical testing revealed that these highly entangled networks possess stiffness values more than 33 times greater than standard hydrogels, with interfacial adhesion energies exceeding 300 J/m² compared to approximately 20 J/m² for conventional options.

In an ex vivo pediatric model using rabbit tracheas, the application of these adhesives to malacic segments completely prevented airway collapse under negative pressure, maintaining patency throughout repeated respiratory cycles. By combining superior mechanical strength with durable adhesion, this approach offers a robust, biocompatible solution that could significantly reduce the need for high-risk surgical interventions in treating severe tracheomalacia.