Trackea: 3D Pediatric Trachea Reconstruction Technology

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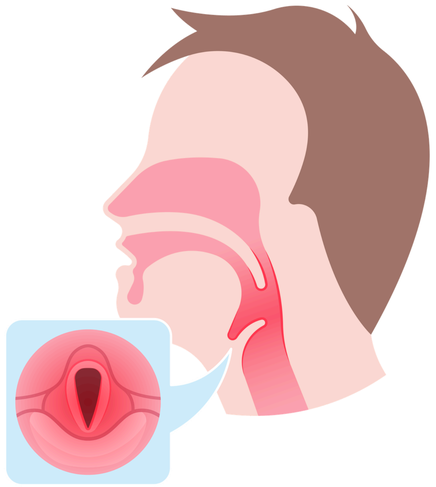
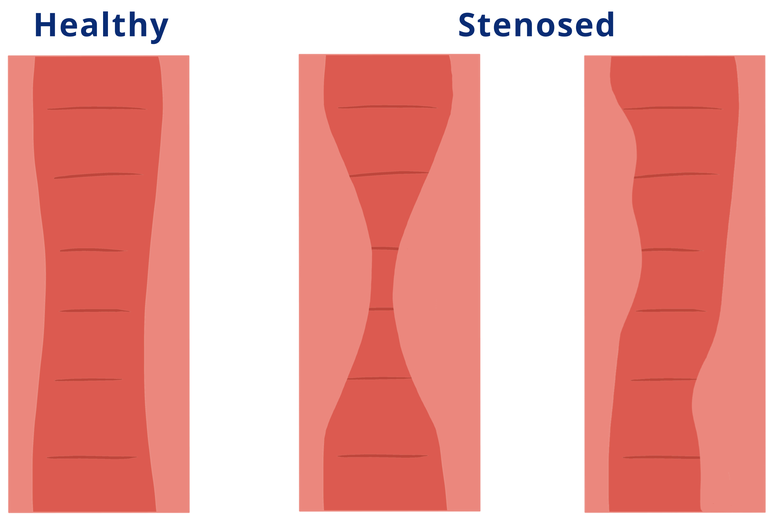
Background

Laryngotracheal Stenosis (LTS) is a narrowing of the airway, often due to birth defects or the growth of inflamed tissue. If left untreated, it can lead to respiratory arrest or the patient requiring a permanent tracheostomy tube.



LTS occurs in **1 in 65,400** live births[1], and if left untreated, the mortality rate of congenital LTS can be as high as **70%.**[2]

Up to 30% of people who are intubated will develop LTS.[3]



Each patient's tracheal geometry is unique, so there is **no one-size-fits-all approach** for treating LTS.

Treatment decisions, such as which procedure(s) to perform and how often, are made based on **location and severity** of the stenosed region. Current methods of assessment do not provide accurate, quantitative information, **especially in the pediatric trachea** (diameter 5-10mm).[4]

References

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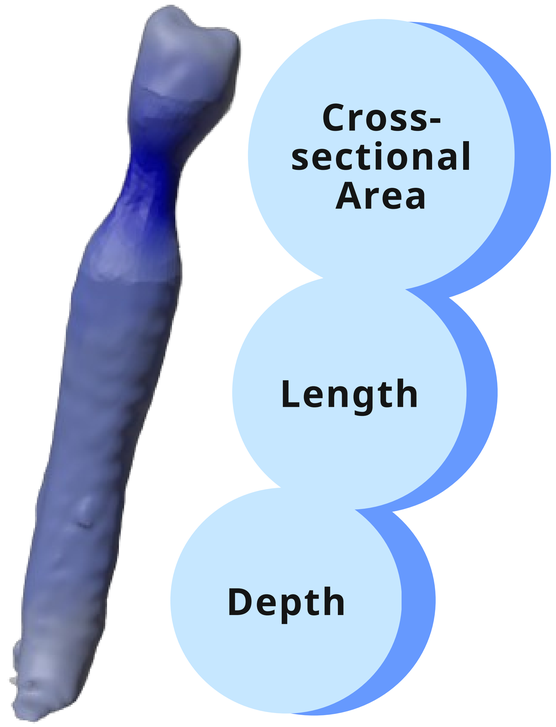
2. Yi SD, Kim SO, Kim CS, Kim SD. Two cases of congenital tracheal stenosis noticed before and after open heart surgery. Korean J Anesthesiol. 1995;28(5):716. doi:10.4097/kjae.1995.28.5.716
3. Zias N, Chroneou A, Tabba MK, et al. Post tracheostomy and post intubation tracheal stenosis: report of 31 cases and review of the literature. BMC Pulm Med. 2008;8:18. Published 2008 Sep 21. doi:10.1186/1471-2466-8-18
4. Dave MH, Kemper M, Schmidt AR, Both CP, Weiss M. Pediatric airway dimensions-A summary and presentation of existing data. Paediatr Anaesth. 2019 Aug;29(8):782-789. doi: 10.1111/pan.13665. Epub 2019 Jun 19. PMID: 31087466.

Need

Pediatric otolaryngologists need to **monitor the geometry** of a patient's laryngotracheal stenosis over time in order to **determine the most effective management strategy**.

Solution

Trackea provides a complete 3D visualization of the whole trachea during an endoscopy, allowing easy measurement of stenosed areas and treatment planning in real time.



Needs Addressed:

- Integrates into standard rigid endoscopy workflow, displaying results in minutes
- Measures depth, length, and cross-sectional area (CSA) with sub-mm resolution
- Displays interactive model with color-coded CSA
- Compares trachea measurements before and after each stage of treatment

Results

- Distance measurements from device correlate to true distances between 1.5-6.5mm with $R^2 = 0.98$
- Device retains accuracy when moved at 5mm/s through trachea model
- 3D reconstruction software generates model with Dice scores between 0.85-0.94
- Average CSA residual of 38 voxels compared to CT scan (total CSA ranges from 700-2100 voxels)