Project references:

Development and Evaluation of Materials and Technologies for Creating Biomimetic Models Designed for Neonatal/Infant Minimally Invasive Surgery Training (3DPHANT)

Principal investigator: prof. Ing. Radovan Hudák, PhD.

1. Salimah W, Norgrove P, Doreen N. et al. The global challenges of surgical congenital anomalies: Evidence, models, and lessons. Semin Pediatr Surg. 2023 Dec;32(6):151348. DOI: 10.1016/j.sempedsurg.2023.151348.
2. Dolk H, Loane M, Garne E. et al. The prevalence of congenital anomalies in Europe. Adv Exp Med Biol. 2010:686:349-64. DOI: 10.1007/978-90-481-9485-8_20.
3. Jaureguizar E, Vazquez J, Murcia J. et al. Morbid musculoskeletal sequelae of thoracotomy for tracheoesophageal fistula. J Pediatr Surg 1985. Oct;20(5):511e4. DOI: 10.1016/s0022-3468(85)80477-2.
4. Steyaert H, Valla JS. et al. Minimally invasive urologic surgery in children: an overview of what can be done. Eur J Pediatr Surg. 2005 Oct;15(5):307-13. DOI: 10.1055/s-2005-865805.
5. Jackson H, Timothy D, Kane J. et al. Advances in minimally invasive surgery in pediatric patients. Adv Pediatr. 2014 Aug;61(1):149-95. DOI: 10.1016/j.yapd.2014.03.011.
6. Borselle D, Grochowski K, Gerus S. et al. Thoracic Musculoskeletal Deformities Following Surgical Treatment of Esophageal Atresia - Thoracoscopic Versus Open Approach: A Retrospective Two Centers Cohort Study. J Pediatr Surg. 2024 Sep;59(9):1719-1724. DOI: 10.1016/j.jpedsurg.2024.03.023.
7. Schukfeh N, Kuebler J, Dingemann J. et al. Thirty Years of Minimally Invasive Surgery in Children: Analysis of Meta-Analyses. Eur J Pediatr Surg. 2020. Oct;30(5):420-428. doi: 10.1055/s-0039-1687901.
8. Blinman T, Ponsky T. et al. Pediatric minimally invasive surgery: laparoscopy and thoracoscopy in infants and children. Pediatrics. 2012 Sep;130(3):539-49. DOI: 10.1542/peds.2011-2812.
9. Rahman AM, Kumar S. et al. Minimal Access Surgery in Neonates. J Neonatal Surg. 2017 Aug 10;6(3):59. DOI: 10.21699/jns.v6i3.614.
10. Tejo-Otero A, Fenollosa-Artés F, Achaerandio T. et al. Soft-Tissue-Mimicking Using Hydrogels for the Development of Phantoms. *Gels* 2022, *8*, 40. DOI:org/10.3390/gels8010040.
11. Kirlum H, Heinrich M, Till H. et al. The rabbit model serves as a valuable operative experience and helps to establish new techniques for abdominal and thoracic endosurgery. Pediatr Surg Int (2005) 21: 91–93 DOI 10.1007/s00383-004-1330-4.
12. Bergman J, Ingeborg B, et al. Surveillance of multiple congenital anomalies; searching for new associations. Eur J Hum Genet. 2024 Apr;32(4):407-412. DOI: 10.1038/s41431-023-01502-w
13. Moita CP, Figueiredo C, Cruz Z, et. al. Surgical Management Of Congenital Thoracic Disorders: A 15-Year Center Experience. Port J Card Thorac Vasc Surg. 2024 Jul 7;31(2):23-29. DOI: 10.48729/pjctvs.418.
14. Zahradnikova P, Babala J, Pechanová R. et al. Inanimate 3D printed model for thoracoscopic repair of esophageal atresia with tracheoesophageal fistula. Front Pediatr. 2023 Nov 14:11:1286946. DOI: 10.3389/fped.2023.1286946. 2023.
15. Zahradníková P, Hnilicová S, Lindák M. Validation study of synthetic models for esophageal atresia with tracheoesophageal fistula (EA/TEF): A simulation-based training in pediatric surgery. Journal: Journal of Pediatric Surgery Open, 2025, p. 100180. DOI:org/10.1016/j.yjpso.2024.100180.
16. Patel EA, Aydın A, Desai A. et al. Current status of simulation-based training in pediatric surgery: A systematic review. J Pediatr Surg. 2019 Sep;54(9):1884-1893. DOI: 10.1016/j.jpedsurg.2018.11.019.
17. Zimmermann P, Wiseman AX, Sanchez O, et al. The avian model: a novel and cost-effective animal tissue model for training in neonatal laparoscopic surgery. J Ped Endosc Surg 2019;1:99–105. doi:10.1007/s42804-019-00027-8.

18. Botden SMBI, Bökkerink GM, Leijte E, et al. Training the component steps of an extra-corporeal membrane oxygenation (ECMO) cannulation outside the clinical setting. J Artif Organs 2020;23:328–34. doi:10.1007/s10047-020-01176-x.
19. Ling JA, Bökkerink GMJ, de Blaauw I, Botden SMBI. Development of a posterior sagittal anorectal surgical teaching model. BMC Pediatr 2021;21(1):57. Jan 27. doi:10.1186/s12887-021-02514-5.
20. Retrosi G, Cundy T, Haddad M, Clarke S. Motion analysis-based skills training and assessment in pediatric laparoscopy: construct, concurrent, and content validity for the eoSim simulator. J Laparoendosc Adv Surg Tech A. 2015;25(11):944–50 Nov. doi:10.1089/lap.2015.0069.
21. Antonio E. Forte, Stefano Galvan, Francesco Manieri, Ferdinando Rodriguez Baena, Daniele Dini, A composite hydrogel for brain tissue phantoms, Materials & Design, Volume 112, 2016, Pages 227-238, ISSN 0264-1275, doi: 10.1016/j.matdes.2016.09.063.
22. Sarah-Jane Estermann, Dieter H. Pahr, Andreas Reisinger, Quantifying tactile properties of liver tissue, silicone elastomers, and a 3D printed polymer for manufacturing realistic organ models, Journal of the Mechanical Behavior of Biomedical Materials, Volume 104, 2020, 103630,ISSN 1751-6161, doi: 10.1016/j.jmbbm.2020.103630.
23. Leibinger, A., Forte, A.E., Tan, Z. *et al.* Soft Tissue Phantoms for Realistic Needle Insertion: A Comparative Study. *Ann Biomed Eng* 44, 2442–2452 (2016). doi/10.1007/s10439-015-1523-0
24. T. Distler, E. Schaller, P. Steinmann, A.R. Boccaccini, S. Budday, Alginate-based hydrogels show the same complex mechanical behavior as brain tissue, Journal of the Mechanical Behavior of Biomedical Materials, Volume 111, 2020, 103979, ISSN 1751-6161, doi: 10.1016/j.jmbbm.2020.103979.
25. Anthony J.A. Baker, Eric J. Galindo, James D. Angelos, Dustin K. Salazar, Sorcha M. Sterritt, Adam M. Willis, Michaelann S. Tartis, Mechanical characterization data of polyacrylamide hydrogel formulations and 3D printed PLA for application in human head phantoms, Data in Brief, Volume 48, 2023, 109114, ISSN 2352-3409, doi :10.1016/j.dib.2023.109114.
26. 3D Extrusion Printing of Biphasic Anthropomorphic Brain Phantoms Mimicking MR Relaxation Times Based on Alginate-Agarose-Carrageenan Blends David Kilian, Wolfgang Kilian, Adriano Troia, Thanh-Duc Nguyen, Bernd Ittermann, Luca Zilberti, and Michael Gelinsky ACS Applied Materials & Interfaces 2022 *14* (43), 48397-48415, doi: 10.1021/acsami.2c12872
27. Lisa Falland-Cheung, Mario Scholze, Niels Hammer, J. Neil Waddell, Darryl C. Tong, Paul A. Brunton, Elastic behavior of brain simulants in comparison to porcine brain at different loading velocities, Journal of the Mechanical Behavior of Biomedical Materials, Volume 77, 2018, Pages 609-615, ISSN 1751-6161, doi: 10.1016/j.jmbbm.2017.10.026.
28. van Oosten, A.S.G., Chen, X., Chin, L. *et al.* Emergence of tissue-like mechanics from fibrous networks confined by close-packed cells. *Nature* 573, 96–101 (2019). doi: 10.1038/s41586-019-1516-5
29. Tejo-Otero A, Fenollosa-Artés F, Achaerandio I, Rey-Vinolas S, Buj-Corral I, Mateos-Timoneda MÁ, Engel E. Soft-Tissue-Mimicking Using Hydrogels for the Development of Phantoms. *Gels*. 2022; 8(1):40. doi: 10.3390/gels8010040
30. Adams, F., Qiu, T., Mark, A. *et al.* Soft 3D-Printed Phantom of the Human Kidney with Collecting System. *Ann Biomed Eng* **45**, 963–972 (2017). doi/10.1007/s10439-016-1757-5
31. Bieniosek MF, Lee BJ, Levin CS. Technical note: characterization of custom 3D printed multimodality imaging phantoms. Med Phys. 2015;42:5913–5918.
32. Leary M, Kron T, Keller C, et al. Additive manufacture of custom radiation dosimetry phantoms: an automated method compatible with commercial polymer 3D printers. Mater Des. 2015;86:487–499.
33. Chen SJS, Hellier P, Gauvrit JY, et al. An anthropomorphic polyvinyl alcohol triple-modality brain phantom based on Colin27 for use in multimodal imaging. Med Phys. 2012;39:554–561.
34. Seoung Y-H. Evaluation of usefulness for quality control phantom of computed tomography produced by using fused deposition modeling 3D printing technology. JEng Appl Sci. 2017;12:3137–3141.
35. Schindera ST, Nelson RC, Howle L, Nichols E, DeLong DM, Merkle EM. Effect of varying injection rates of a saline chaser on aortic enhancement in CT angiography: Phantom study Eur Radiol. 2008;18:1683–9