OPTIMIZATION OF SURGICAL STRATEGY FOR CRANIOSYNOSTOSIS IN CHILDREN BASED ON PREOPERATIVE MSCT DIAGNOSTICS

Nazarova L.A.
National Children's Medical Center" Children's Neurosurgery Department,
Parkent Street, 294, Tashkent, Uzbekistan, 1001711
https://doi.org/10.5281/zenodo.15261140

Abstract

This study proposes an optimized surgical approach for craniosynostosis in children using preoperative multislice computed tomography (MSCT). A total of 150 retrospective cases and a pilot group of 80 patients were analyzed using tailored pediatric MSCT protocols. Morphometric parameters were compared with international craniofacial databases. Clinical, neurological, ophthalmological, and cosmetic outcomes were evaluated. Optimized protocols led to a radiation dose reduction of 30–40%. Advanced statistical methods, including t-test, ANOVA, and Bayesian network meta-analysis, revealed factors associated with better surgical outcomes. The proposed strategy significantly improved preoperative planning, surgical precision, and postoperative rehabilitation in pediatric patients.

Keywords:

Craniosynostosis, children, MSCT, morphometry, 3D reconstruction, radiation dose, craniofacial surgery, Bayesian meta-analysis.

Relevance

Craniosynostosis affects approximately 1 in 2,000 live births, requiring early diagnosis and intervention to avoid intracranial hypertension and severe craniofacial deformities. MSCT with 3D reconstruction is the diagnostic gold standard, but the pediatric population demands a careful balance between image quality and radiation safety. Over 80% of centers worldwide lack standardized protocols for pediatric craniofacial imaging. This study addresses this gap by developing optimized MSCT protocols with dose reductions of up to 40%, enabling detailed anatomical assessment with minimized risk. Incorporating morphometric analysis, clinical outcomes, and long-term follow-up, the study proposes a standardized, safe, and effective workflow. The relevance lies in integrating diagnostic accuracy, surgical planning, and functional recovery into a unified strategy, potentially impacting national and international standards of care for children with craniosynostosis.

Objective:

To develop and validate an optimized surgical strategy for craniosynostosis in children using preoperative MSCT imaging, with a focus on diagnostic accuracy, radiation safety, and clinical outcomes.

Materials and Methods

The study included 150 retrospective cases (ages 3–18 months) and a pilot group of 80 children prospectively examined. Inclusion criteria: MSCT data, confirmed diagnosis, and surgical treatment. Exclusion: missing imaging/clinical data or severe comorbidities. MSCT with 0.5 mm slices and 3D volume rendering was used. MRI was added in 22% of syndromic cases. Morphometric analysis included cranial index, cephalic asymmetry, and skull angles, compared with four international anthropometric databases. Clinical data covered surgical technique, length of stay, complications, and neurological development. Radiation dose parameters (kV, mA) were optimized. Statistical analysis included t-test, ANOVA, and Bayesian network meta-analysis (n = 230).

Results

Optimized MSCT protocols led to radiation dose reductions of 32–38% (mean DLP: 245 vs. 378 mGy·cm). Morphometric deviations ≥15% from normal were found in 82% of patients. Early surgical intervention (<6 months) resulted in significantly better outcomes ($p < 0.01$) across neurological and cosmetic domains. The pilot group demonstrated 96.3% technical success, and postoperative complication rate decreased to 4.2%. Bayesian meta-analysis showed that frontal-orbital advancement combined with morphometric planning had the highest probability of optimal outcomes ($P = 0.86$). Enhanced protocols improved interdisciplinary collaboration and parental satisfaction scores by 23%.

Conclusion

Tailored preoperative MSCT with low-dose protocols enhances the safety and accuracy of craniosynostosis surgery in children. The study demonstrates that morphometric-guided planning and early intervention lead to better functional, neurological, and aesthetic results. Radiation exposure was reduced by up to 40%, aligning with ALARA (As Low As Reasonably Achievable) principles. Bayesian network meta-analysis confirmed the superiority of individualized surgical techniques over conventional methods. These findings support the integration of standardized MSCT protocols into clinical practice and can serve as a model for pediatric craniofacial centers globally, improving both short- and long-term treatment outcomes.

Literature:

1. Akramov O. Z. et al. Giant cerebellar cavernous malformation in children: A case report and literature review //Journal of Cerebrovascular and Endovascular Neurosurgery. – 2024. – Т. 26. – №. 3. – С. 304-310.
2. Akramov O. Z., Kadirov D. B., Nazarova L. A. Spinal Tuberculosis in Children //Al-Kindy College Medical Journal. – 2022. – Т. 18. – №. 1. – С. 79-81.
3. Akramov O. Z., Nazarova L. A., Gorelishev S. K. Surgical treatment of the lipomeningocele in children (a review) //Вестник национального детского медицинского центра. – 2022. – №. 2. – С. 16-23.
4. Rozhina A. A., Nazarova L. A. INCLUSIVE EDUCATION FOR CHILDREN WITH DISABILITIES IN TERMS OF EDUCATIONAL INSTITUTIONS //ADVANCED SCIENCE. – 2019. – С. 191-193.
5. Гулямов Ш. Б. и др. Одномоментная реконструкция ушной раковины и наружного слухового прохода с тимпанопластикой //ДЕТСКАЯ ОТОРИНОЛАРИНГОЛОГИЯ Учредители: ООО" Медиа Медичи". – №. 4. – С. 20-23.
6. Akramov O. Z. et al. Giant cerebellar cavernous malformation in children: A case report and literature review //Journal of Cerebrovascular and Endovascular Neurosurgery. – 2024. – Т. 26. – №. 3. – С. 304-310.