Sacral ratio correlates with spinal and sacral anomalies in children with anorectal malformation

Alberto Gubert[1], Marc Georges[1], Sabine Vasseur Maurer[1], Ana Carolina Rocha[2], Leonor Trinidad Alamo-Maestre[2], Eleuthère Stathopoulos[1]

[1] Department of Pediatric Surgery, CHUV - Lausanne University Hospital, Lausanne, Switzerland
[2] Department of Radiodiagnostic and Interventional Radiology, CHUV - Lausanne University Hospital, Lausanne, Switzerland

Introduction

Vertebral (28-50%) **and spinal cord** (10-52%) **anomalies** are frequently found in children born with anorectal malformation (ARM). Conventional **x-ray** and spinal **ultrasound** are used for vertebral and spinal investigations. **MRI** has emerged as a key tool for the preoperative evaluation of patients with ARM, providing detailed information on malformation type and associated anomalies.

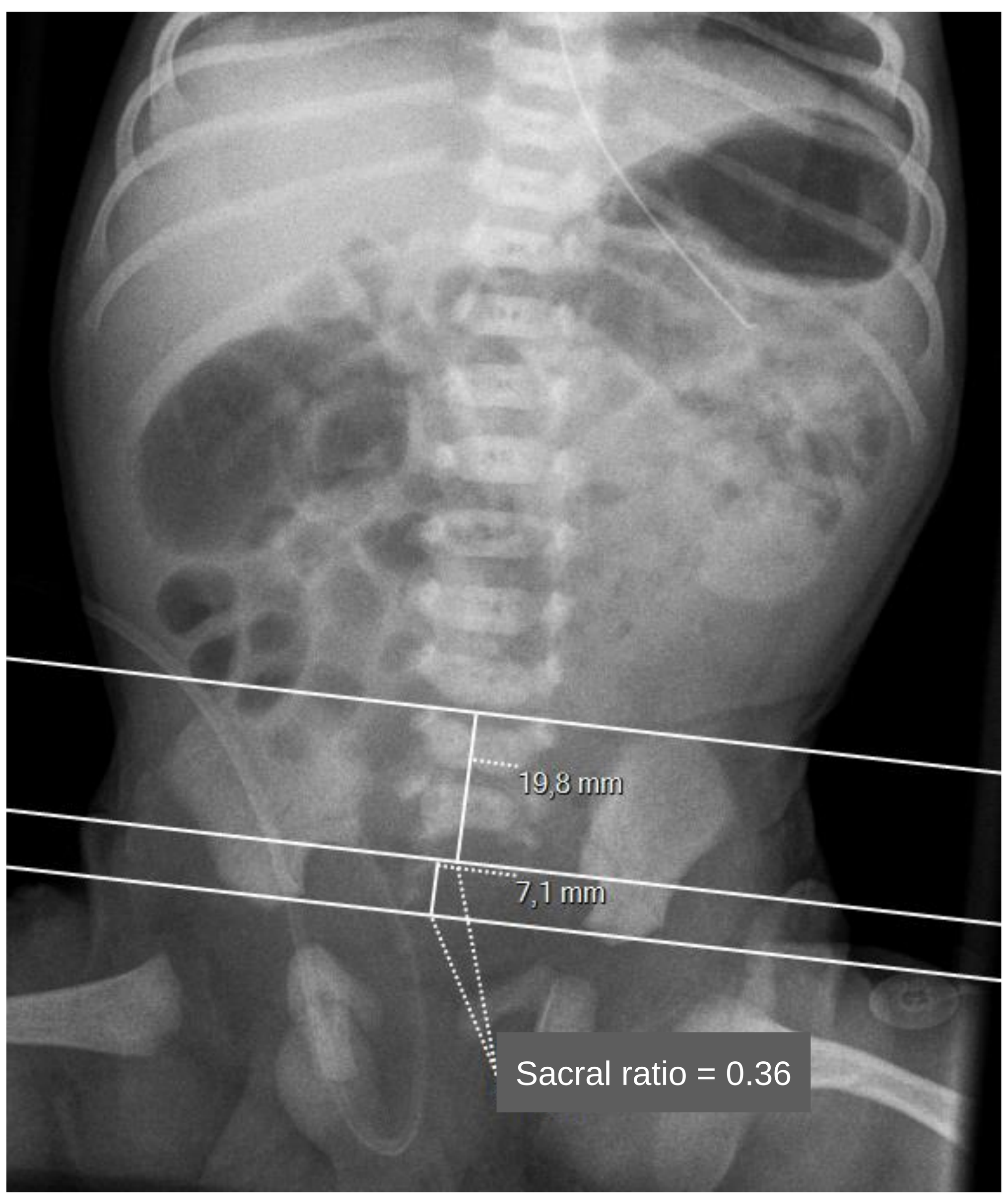
The **sacral ratio** (SR) as proposed by Alberto Peña, is a ratio measured on conventional x-ray and has been used as a prognostic factor. The underlying thinking is that it reflects an abnormal anatomy of the spine or the spinal cord.

A ratio above 0.7 is considered normal, whereas a ratio below 0.5 is generally associated with poor functional outcomes.

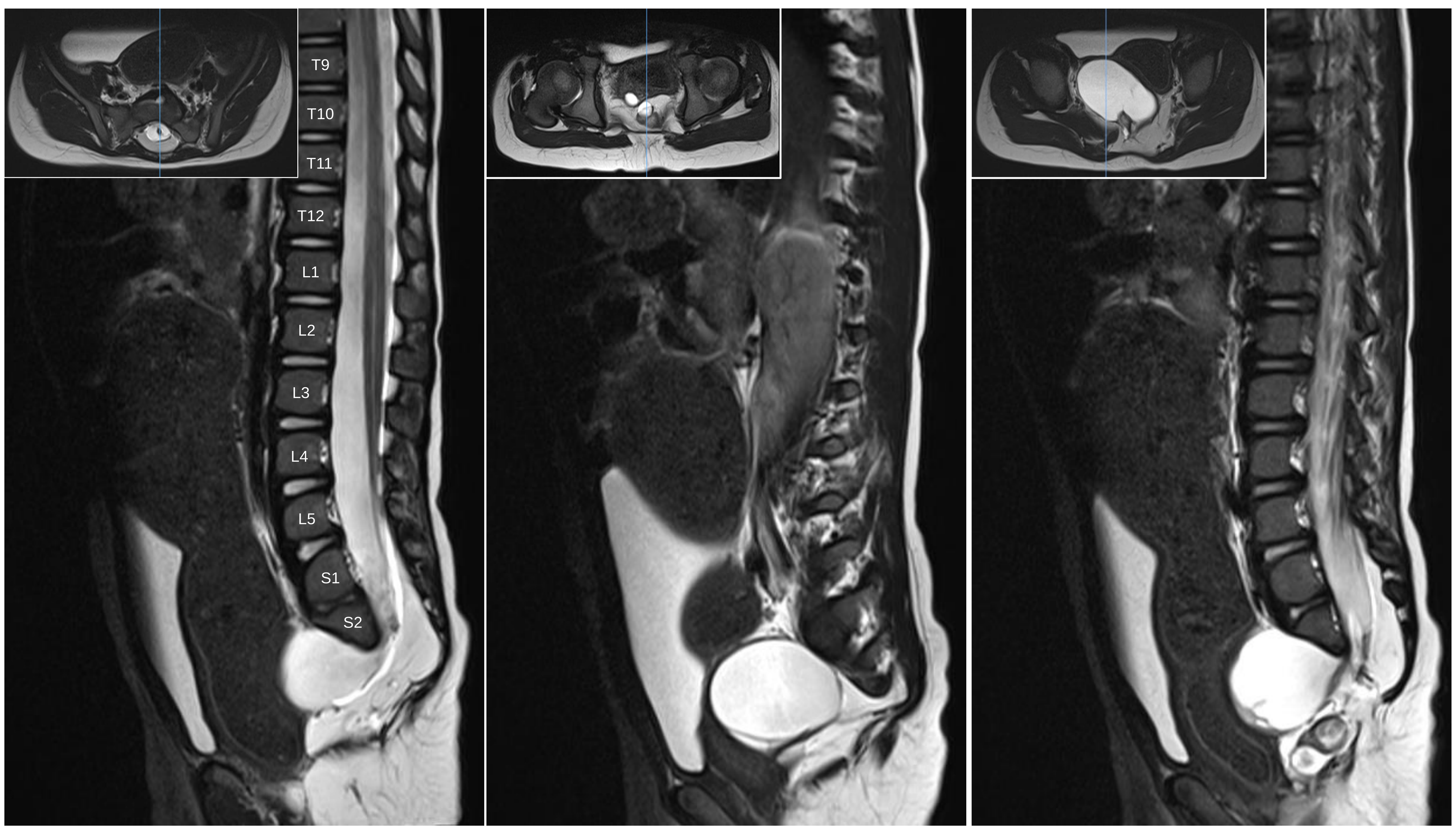
Despite its frequent use, *the relationship between the sacral ratio and the anatomy of the spine and spinal cord has not been investigated.*

In our Institution, children born with ARM have been undergoing systematic spinal cord and pelvic MRI since 1995.

This project aims to investigate the anatomical significance of the sacral ratio.



Radiological findings of the same patient.
Boy with Currarino syndrome: perineal fistula ARM type, sacral agenesis (2 sacral vertebra), anterior meningocele.
The x-ray above illustrates the difficulty in measurement of SR.
Spine and spinal cord anomalies are illustrated on MRI below.



Purpose

We investigated the correlation of sacral ratio measured on conventional x-ray with spinal cord and sacral malformations diagnosed on MRI in children born with ARM.

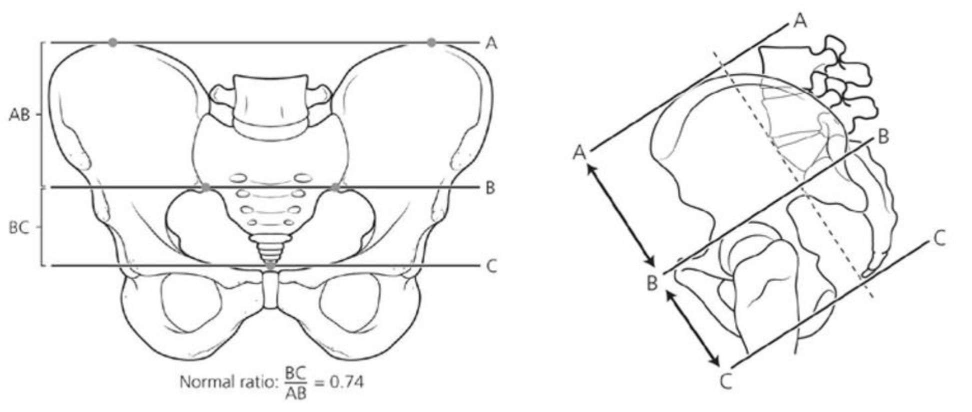
Method

Retrospective study of children with ARM managed in our Institution from 2000 to 2025.

Inclusion criteria: child born with an ARM (Krickenbeck classification), informed consent obtained, conventional x-ray of the spine, spinal cord and pelvic MRI.

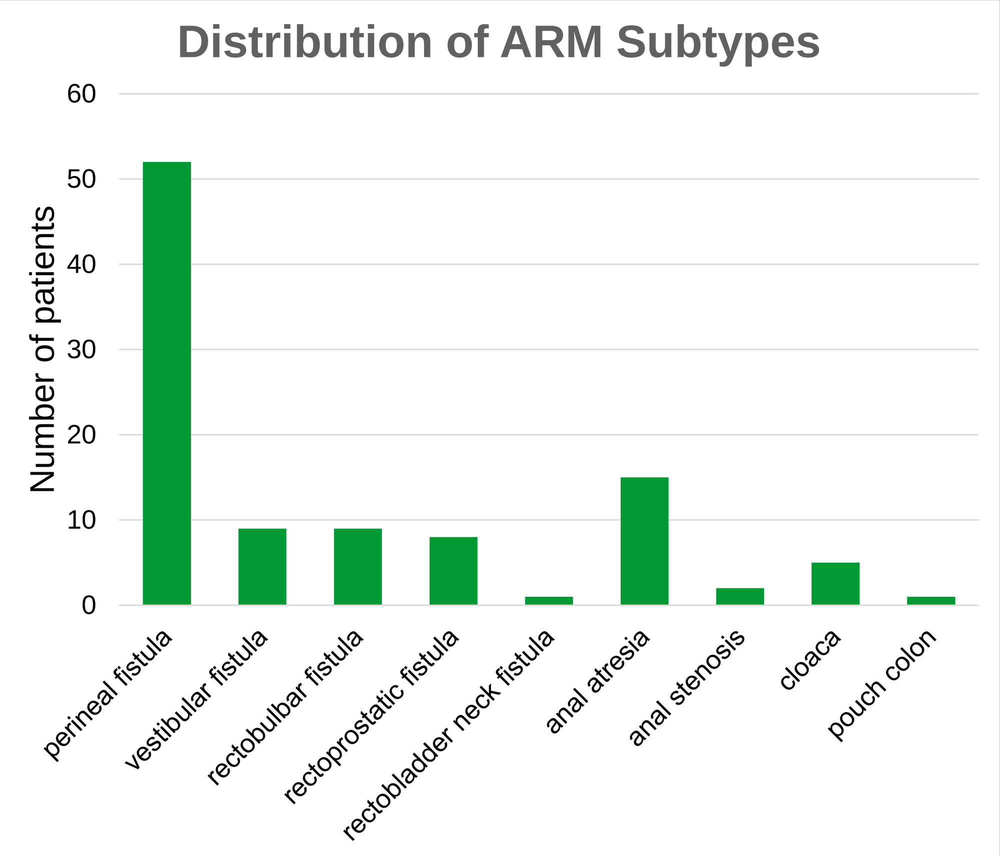
SR was measured by two observers on the best x-ray available. Discrepancy between the two observers was discussed with a trained pediatric radiologist.

SR was calculated as the ratio of the length of the sacroiliac joint to the coccyx to the length of the iliac crest to the sacroiliac joint.



Metzger G, Cooper JN, Kabre RS, et al. Inter-rater Reliability of Sacral Ratio Measurements in Patients with Anorectal Malformations. *J Surg Res*. 2020;256:272-281.

Spinal cord and sacral anatomy was assessed on MRI. Spinal cord anomaly included thickened filum, tethered cord, lipoma, meningocele; sacral anomaly was defined as dysplasia or agenesis of sacral vertebrae.



Results

102 ARM patients out of 214 were included. Among the 112 excluded patients, 38 did not have full radiological investigation, 74 did not give consent.

22/102 (21.6%) had spinal cord anomaly and 28/102 (27.5%) had sacral anomaly.

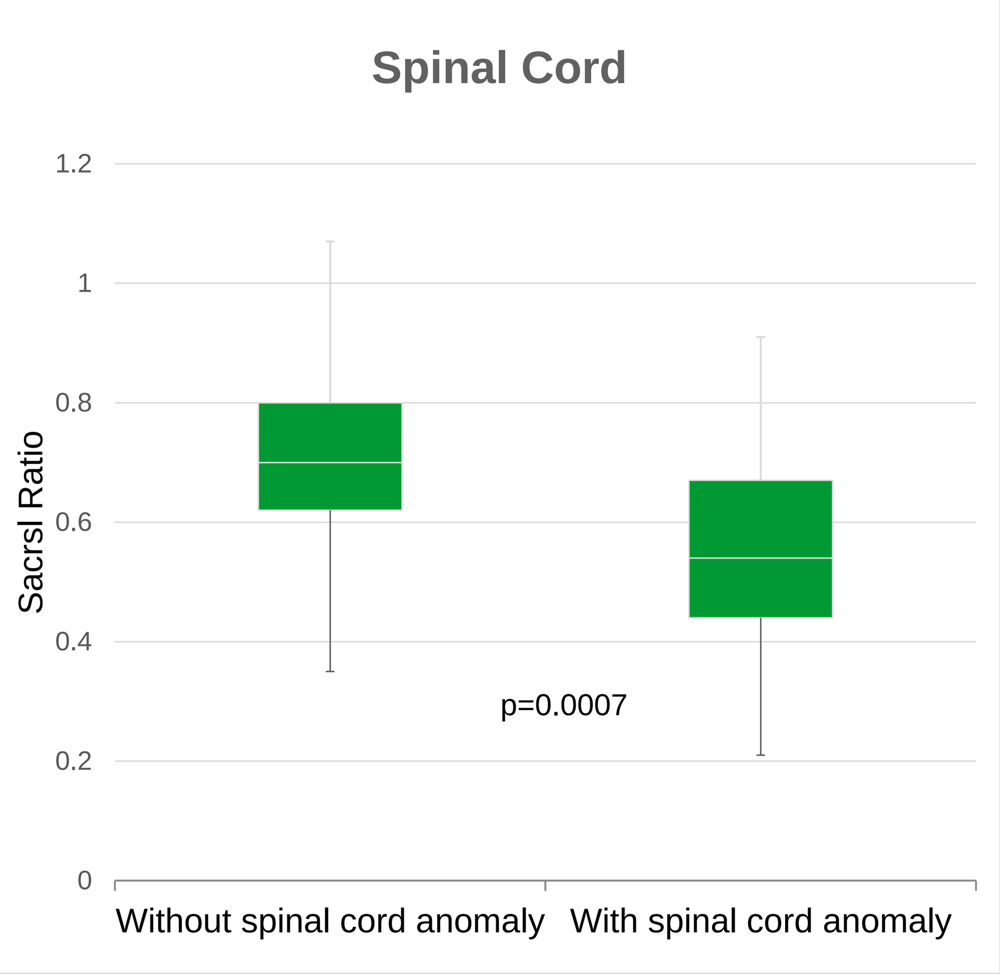
Interobserver SR variability was not significant (0.66 ± 0.18 vs 0.65 ± 0.18, p=0.70).

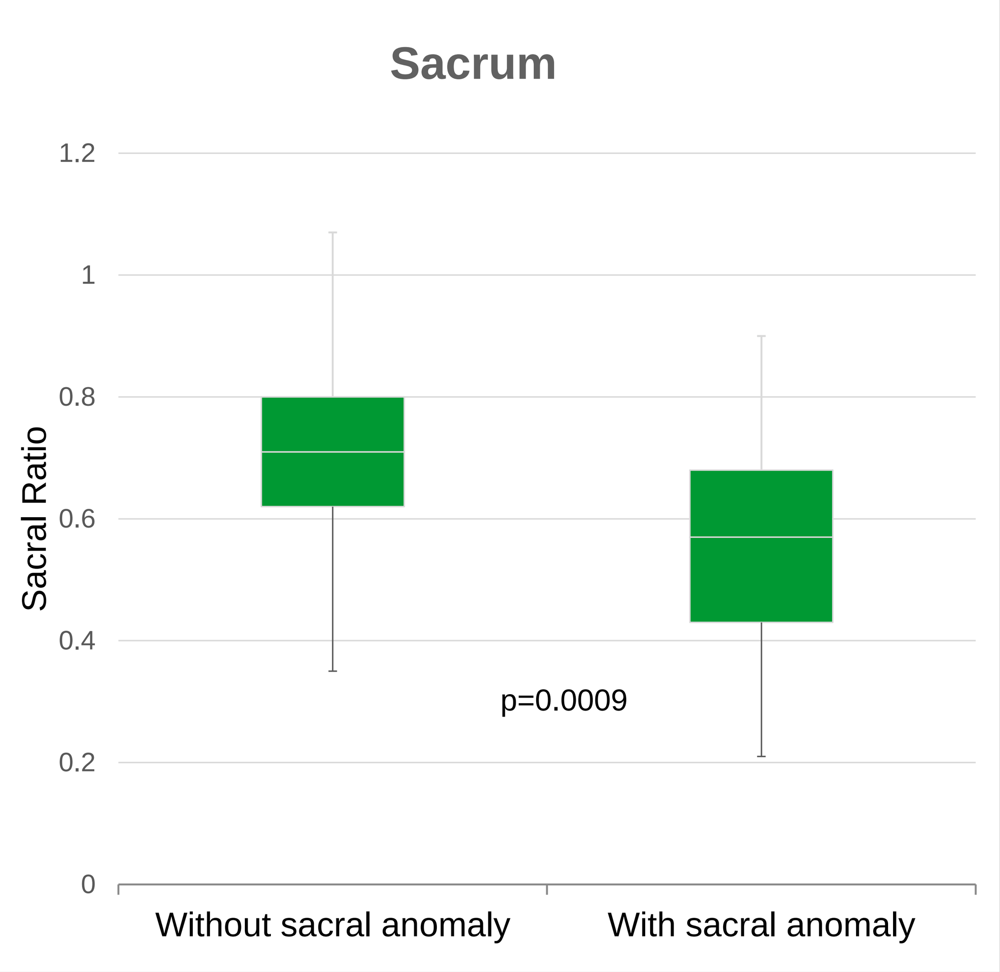
69 ARM patients had **neither** spinal cord nor sacral anomalies; their SR was 0.70 ± 0.16.

SR in children with any type of ARM and **spinal cord anomaly** was significantly lower compared to children without spinal cord anomaly (0.53 ± 0.18 vs 0.69 ± 0.16, p=0.0007).

SR in children with any type of ARM and **sacral anomaly** was significantly lower compared to children without sacral anomaly (0.56 ± 0.19 vs 0.7 ± 0.16, p= 0.0009).

Significant differences in SR were observed among subgroups defined by ARM subtype, presence or absence of spinal cord anomalies and presence or absence of sacral anomalies (p = 0.0189, not illustrated).





Conclusions

SR measured on x-ray may suggest associated spinal cord or sacral anomaly.

SR may be used to identify patients who would benefit from an MRI.

Larger studies are required to establish a cut-off value of SR for normal anatomy of spinal cord and sacrum.

Alberto Gubert Alberto.Gubert@chuv.ch
Marc Georges Marc.Georges@chuv.ch
Eleuthère Stathopoulos Eleuthere.Stathopoulos@chuv.ch