Late consequences after surgery of left sided diaphragmatic hernia in children: lung volumes and blood flow

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Purpose:
To evaluate pulmonary arterial and cardiac findings in children operated for left-sided diaphragmatic hernia in comparison with age- and size-matched healthy children.

Material and Methods:
Twelve children (median age: 12 years, range 6-18 years) who received immediate postnatal surgery for closure of isolated diaphragmatic hernias between 1985 and 2001) were included. After a clinical interview, children received extensive pulmonary function testing and standard echocardiography. MRI examinations were done at a 1.5 T system (Avanto, Siemens) using True-FISP imaging for functional evaluation and velocity encoded gradient echo imaging (VENC: 150 cm/s) to allow flow measurements of the main (MPA), the right (rPA) and the left (lPA) pulmonary artery, respectively. Data were compared to 12 age- and size-matched healthy children using the Wilcoxon-Matched-Pairs test (level of significance: 5%).

Results:
Clinical examination years after surgery for diaphragmatic hernia revealed no pathologic findings, neither in patients nor in probands. Furthermore, echocardiography and pulmonary function testing was inconspicuous.
Cardiac and pulmonary arterial MRI revealed several differences between patients and probands, which reached significance to a certain extent (Table 1).

Parameter (mean values)	Units	Patients	Probands	Significance
Short axis examination				
Heart rate	bpm	93	79	p=0.03
Ejection fraction	%	71	67	p=0.05
Enddiastolic volume	ml	72	96	p=0.05
Endsystolic volume	ml	21	32	p=0.05
Stroke volume (left ventr.)	ml	51	64	p=0.04
Flow measurements				
Stroke volume (right ventr.)	ml	57	70	p=0.04
Stroke volume (lPA)	ml	22	32	p<0.001
Stroke volume (rPA)	ml	33	37	p=0.3
Flow MPA	l/min	5.2	5.4	p=0.9
Flow lPA	l/min	2.1	2.5	p=0.02
Flow rPA	l/min	3	2.8	p=0.3
Area MPA	cm^2	4.2	4.2	p=1
Area lPA	cm^2	1.4	1.8	p=0.02
Area rPA	cm^2	1.6	1.6	p=1

Conclusion:
Though subclinically, patients who received surgery for left-sided diaphragmatic hernia revealed significantly reduced cardiac performance. To compensate this, the heart rate is increased. Furthermore, the flow parameters of the left pulmonary artery in patients are reduced and blood flow is shifted to the right side. These findings are in accordance with scintigraphical findings reported earlier, indicating left sided lung hypoplasia after left-sided diaphragmatic hernia (1).

Literature
1. Ritter L, Otto HJ, Huhnerbein J, Thal W, Sollich V, Schuster R. Findings of combined ventilation/perfusion scintigraphy in children with abnormalities of the bronchi, the lung and lung blood vessels. Kinderarztl Prax. 1993 Feb;61(1):12-8.