largely asymptomatic. However, the final outcome and possible coronary insufficiency remains unclear. It has been considered that coronary flow reserve (CFR) may be reduced in this population. Myocardial blood flow (MBF) was assessed at rest and during maximal hyperemia using N-13 ammonia PET before and after intravenous adenosine infusion in 22 children (mean age 12 ± 2 years). MBF and CFR were compared with a group of healthy volunteers.

Results: A stress-induced perfusion defect was noted in 4 patients. Mean resting MBF was higher in patients than in volunteers (0.97±0.27 vs. 0.74±0.14, p=0.04), while stress MBF was reduced (2.74±0.44 vs. 3.48±0.59, p=0.001). CFR in patients was significantly lower than in controls (2.96±0.60 vs. 4.75±0.81, p<0.0001). Myocardial vascular resistance (MVR) was lower at rest in patients (97.87+21.3 vs. 125.08± 25.06, p=0.006), while stress MVR tended to be higher.

Conclusion: Patients with surgically corrected TGA show reduced coronary flow reserve compared with healthy young adults. Quantitative PET assessment of CFR may thereby reveal functional abnormalities in these patients prior to the appearance of perfusion defects.

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Malformations of the pulmonary artery evaluated by MRI

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Surgical treatment of patients with pulmonary atresia, central or peripheral pulmonary stenoses requires accurate definition of the pulmonary vascular status.

Magnetic resonance images of 108 patients (9 PA with IVS, 55 PA with VSD, 10 PA with TA, 12 PA with SV, 9 aplasia of one pulmonary artery, 13 central pulmonary stenosis) were compared with echocardiographic (108) and angiocardiographic (80) findings. 66 patients had undergone palliative surgery with placement of 67 systemic-to-pulmonary shunts. Cardiac ECG-gated MRI studies were performed using a multislice spin echo technique and at least one of 3 different 'white blood' imaging techniques. A 3D-gradient echo sequence with 1 mm slice thickness was applied in 36 patients.

The morphology and size of the pulmonary arteries could be accurately assessed in all patients. MRI discovered unknown hypoplastic pulmonary arteries in 23 patients, that was confirmed either by pulmonary vein wedge angiography or surgery. In contrast to angiography MRI was able to demonstrate left or right pulmonary artery in 20 patients with severe central stenoses of the pulmonary artery of native origin (2) or caused by palliative shunts (15), dislocation of a banding (3). Better definition of pulmonary blood supply by aortopulmonary collaterals was achieved in 9 patients. However instead of the capabilities of high resolution MR-angiography the description of the communications and evaluation of the number of segmental pulmonary arteries connected to the poliaterals was unsuccessful in patients with multifocal blood supply. 64 palliative shunts were visualized and could be evaluated for patency in 45 patients, as stenotic in 14 and occluded in 5 patients. We conclude that MRI is an excellent noninvasive technique for diagnosing pulmonary artery malformations, particularly for follow-up studies, but it still needs further development for complete evaluation.

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Simultaneous assessment of myocardial glucose metabolism and contractile function by gated F-18-deoxyglucose positron emission tomography in infants and children after arterial switch operation and suspected myocardial infarction

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Objectives: The F-18-deoxygiucose positron emission tomography (FDG-PET) is well established as the golden standard for detection of myocardial viability in adults. However FDG-PET is not validated so far in small children with special regard to the feasibility and clinical impact of gated data acquisition. Therefore we applied gated PET using a 30 min protocol for complete assessment of the metabolic and functional status of myocardium in very small and older children with suspected or confirmed myocardial injury after switch operation for transposition of the great arteries (D-TGA).

Methods: 5-7 MBq/kg F-1 8-deoxygiucose were injected after stimulation of glycolysis either orally by 2 glkg glucose and 4 ml/kg/h glucose 10% solution (infants) or 20-30 g orally and 15-25 g glucose i.v. combined with insulin i.v. (age > 10 y). Sedation of infants was achieved by chioral hydrate or midazolame i.v. ECG triggered data acquisition (7-12 gates) was started 30 min p.i. for a 20 min emission period, followed by 1 0 min transmission. Glucose metabolism, wall motion and wall thickening were evaluated visually and quantitatively on the basis of parametric 3D-images generated by a new software for wall delineation, which was developed at the Hannover PET center.

Patients: 9 D-TGA patients (5 pts.: age 1-5 months 14 pts.: age 13-16 years) were examined. Infarction or ischemia were suspected in all patients by ECG, echocardiography, coronary angiography or elevated creatine kinase.

Results: 4 children showed no metabolic or functional abnormalities. In one infant with severely impaired LV function (echo: anteroseptal akinesis) FDGPET demonstrated viable myocardium. In addition preserved contractile function was proved by analysis of wall thickening. Therefore indication for revascularisation was derived from this finding. One baby with severe anterior infarction died before revascularisation. Non-transmural infarction was present in 2, transmural scar in one of 3 older children without hibernating or stunned myocardium verified by FDG-PET and MIBI-SPECT.

Conclusion: These preliminary results suggest that myocardial viability and contractile function can be assessed by gated FDG-PET in order to guide further therapy also in small children with congenital coronary abnormalities.

Interventional Cardiology

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Transarterial occlusion of membranous ventricular septal defects by a self-adjustable device

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Transcatheter membranous ventricular septal defect (MVSD) occlusion, is both challenging and time consuming; an appropriate double disk device should have an easy application and should be

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able to be manipulated away from critical structures.
We describe here the results of transarterial MVSD occlusion with a self adjustable device(SAD) constructed by two disks connected by an elastic band; three devices had single wire disks and seven devices had a two wire proximal disk (inverted device).
The device is introduced transarterially through a long sheath (7-8F), crossing the MVSD; the distal disk is introduced first in the right ventricle and the proximal disk in the left ventricle, automatically opposing the first one. Both disks can be manipulated away from critical structures.
Ten patients with MVSD were corrected by the SAD. Their age varied from 4-24 yrs (med=10) and the defect size from 3-12min(med=5); they were corrected by 7 inverted and 3 single wire devices. Single wire devices were selected in cases of inadequate subaortic rim. All cases had effective clinical occlusion with 6 residual trivial shunts. There were no complications and the total procedure time did not exceed 30 minutes.
In conclusion the transarterial application of the SAD is fast, effective and safe in the occlusion of selected MVSDs.

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Stent-dependant neointimal proliferation after stent-implantation into the ductus arteriosus in duct-dependant congenital heart disease

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Transcatheter stenting of the ductus arteriosus has been introduced since 1991 for maintaining ductal patency in patients (pts) with congenital heart disease and duct dependant pulmonary circulation (ddCHD). It has been shown in long term follow ups, that restenosis of the stents are due to specific properties of ductal tissue.
Methods: 14 pts with ddCHD (age 2-57 days; body weight: 1.890g-4.4kg) underwent ductal stenting. In 9 pts Palmaz Shatz stents (group 1; longest observation period 684 days) and in 5 pts NIR stents (group 2, longest observation period: 521 days) were implanted. Peri- and postinterventional management did not differ between both groups. Repeat cardiac catherisation was performed in the event of restenosis. From initial and follow-up cineangiograms, external stent and inner lumen diameters were examined.
Results: All children survived the initial procedure. During the first month 1 successful repair and one death was recorded (both group 1). Restenosis occured in all of the 7 pts of group I with a narrowing of the inner lumen of mean 40.6% after 5 months and to 61.5% after 9 months, and analogue after redilation. In group 2 all pts developed a narrowing of the inner lumen of only 15 to 25% after 6 to 12 months after stent implantation. In group 1 18 redilations (2.6 redilations/pts) while in group 2 only 1.6 redilations/pts had to be performed.
Conclusion: Neointimal proliferation causes recurrent obstruction of the stent after ductal stenting. Our preliminary data suggest that besides the special properties of the ductal tissue stent dependant differencies are responsible for the degree of proliferation and stent narrowing.

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Pulmonary atresia with intact ventricular septum percutaneous radiofrequency (RF) valvotomy and balloon dilatation vs. Surgical valvotomy and Blalock Taussig (BT) shunt

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A selected group of 26 patients with pulmonary atresia and intact ventricular septum underwent either closed surgical pulmonary valvotomy and BT Shunt or percutaneous radiofrequency valvotomy (PRV) and balloon valvuloplasty between Sept 1992 to Aug. 1997 in our institution in an unrandomised manner. All patients in both groups had patent infundibulum with mild to moderate right ventricular (RV) hypoplasia and none had right ventricle dependent coronary circulation. Patients with severely hypoplastic RV or RV dependent coronary circulation were excluded. Percutaneous RF valvotomy and balloon valvuloplasty was successfully performed in 13 patients (group 1). Closed surgical valvotomy and BT Shunt was performed in 13 patients (group 2) including 2 patients in whom the transcatheter approach failed. There was no statistical significance between the 2 groups in terms of age at presentation and body weight. In group 1, 1 patient required BT Shunt and I underwent PDA stenting for persistent prostaglandin dependence. Mean RV pressure dropped from 117 to 58 mmHg. I patient required repeat balloon dilatation after 6 months for restenosis. There were no hospital death but there were 2 late deaths. 6 patients have complete biventricular and required no further intervention. 2 patients underwent hemi-Fontan procedure for inadequate RV growth. 3 patients have follow up duration <6 months but no further intervention is likely to be required in 2. In group 2, there were 3 early hospital deaths. Surgical complications of left pulmonary artery stenosis was seen in 1 patient and diaphragmatic paralysis was seen in 2. All early survivors required re-intervention (3 RVOT reconstruction and 7 balloon dilatation). There were further 3 late deaths. Of the 7 survivors 6 underwent coil occlusion of the BT Shunt and have complete biventricular circulation whilst 1 has inadequate RV growth and awaits hemi-Fontan procedure. The total duration of hospital stay, inotropic and ventilatory requirement were significantly in favor of the transcatheter group. In selected patients with pulmonary atresia with intact ventricular septum who have patent infundibulum and mild to moderate RV hypoplasia transcatheter treatment with RF valvotomy and balloon dilatation is a safe and effective alternative to conventional surgery.

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Is there a place for balloon dilatation of the RVOT in tetralogy of Fallot?

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Balloon dilatation of the right ventricular outflow tract as a palliative procedure remains controversial in tetralogy of Fallot in terms of efficacy and growth the pulmonary vascular tree.
Balloon dilatation of the pulmonary valve was attempted in 35 infants with tetralogy of Fallot at a mean age of 3 months (range 0.5 to 10.5 months). Twenty-three of them had associated cardiac anomalies: anomalous origin of the LAD from the right coronary (n = 6), atrioventricular septal defect (n = 3), multiple VSDs (n = 3), large aorto-pulmonary collateral artery (n = 1). Clinical, haemodynamic, angiographic data were collected in all patients.

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The mean balloon to pulmonary annulus ratio was 1.32 ± 0.28. After dilatation, systemic oxygen saturation increased from a mean value of 76 ± 9% to 88 ± 7% ($p < 0.001$). The procedure was safe in all patients. Five patients required early surgical repair because of increasing cyanosis (4 anastomoses and 1 complete surgical repair) and 2 other patients had late anastomosis.
Growth of the pulmonary annulus and pulmonary arteries (Z score) was established at a mean of 6 months after dilatation (n = 17). The pulmonary annulus increased from a Z score mean value of -4.1 ± 0.9 SD to -2.5 ± 1.1 SD ($p < 0.001$), the Z score for the right pulmonary artery from -3.0 ± 0.6 SD to -1.9 ± 1.2 SD ($p = 0.007$) and Z score for the left pulmonary artery from -2.7 ± 0.7 SD to -1.6 1.3 SD ($p = 0.021$). At late follow-up (8 months after dilatation), 28 patients underwent complete correction. Transannular patching was required in 43% of the patients. Three post-operative deaths were observed, none dilatation related.
In conclusion, balloon dilatation of the RVOT is an effective palliative procedure in tetralogy of Fallot which obviates the need for anastomosis in 80%. It promotes significant growth of the pulmonary vascular tree to decrease the need for transannular patch. We would recommend dilatation in symptomatic infants with young age (< 3 months), small pulmonary annulus (Z score < -3 SD), and major associated cardiac anomalies. Patients with severe infundibular hypoplasia are not good candidates for this procedure.

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A new percutaneously adjustable device for PA constriction to cause myocardial hypertrophy of the low-pressure ventricle

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Intention: In corrected transposition of the great arteries (d-TGA) the life expectancy is limited because of RV insufficiency in young adult age. To perform double switch in order to prevent heart transplantation the LV has to be trained pre-op to high pressure conditions to stand systemic stress immediately after operation. Slow progressive constriction of the pulmonary artery (PA) over 4 weeks in contrast to acute PA-banding provokes adequate myocardial hypertrophy without fibrosis or subendocardial ischemia. This might lower the risk of LV-failure after double switch. Hence we developed a percutaneously adjustable PA constrictor (PAC). This trial was designed to assess its safety and effectiveness and evaluate myocardial adaption to well dosed increase in afterload for the low-pressure ventricle. *Device:* PAC functioned as a choke and is like an adjustable clip. The arms of the clip were connected to a steering wire served by a special screw to adjust PACs angle of opening. The resulting PA constriction increased or decreased the afterload of the ventricle. The advantage of this PAC is the possibility to adjust PA-constriction infinitely to individual conditions by closing as well as active opening at any time. *Method:* During general anaesthesia 6 swine underwent median and one lateral thoracotomy. Under stable conditions PAC was placed around the PA and connected to the steering wire which was tunnelled to outside. Afterwards chest was closed. During constriction of PA right atrial, right ventricular and PA pressures, ECG and thermodilution cardiac output were measured. Statistic analysis was performed. *Results:* RVP could he increased up to systemic level until failure of RV with hypotension and highly elevated RVEDP occurred. Remarkable normalisation of all parameters followed as soon as constriction was released. The degree of constriction could be controlled exactly from outside by tightening and loosing the adjustment-screw to modulate the clips angle. Reproducible pressure load or unload of the RV resulted. From the recorded values i.e. RVP and constrictor aperture showed excellent correlation. There was no impairment of intra- or extracardiac structures by the device. *Conclusion:* The developed PAC allows exact individual adjusted increase of RVP by PA constriction. Now long-term experiments over 6 weeks with defined pressure load increase to cause myocardial hypertrophy are necessary to prove long-time effectiveness and safety of the device. An introduction to clinical routine appears to be possible in the future.

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Early experience using intravascular stents in children with coarctation of the aorta: promising results... But proceed with caution!

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Balloon expendable Palmaz stents (ST) are effective in the transcatheter treatment of pulmonary artery stenosis and other vascular obstructions. However, their use in coarctation of the aorta (CoA) is limited. Over 2 yrs, 19 ST (16 P-308, 3 P-188) were implanted in 15 pts: 10 males, 5 females; ages 4.5-15.7, 11.8 yrs; wt 17.4-72.8, 46.5 kg. At cath, balloon aortic angioplasty (BA) was initially attempted before ST in 10 pts: 6 with native CoA [Group 1A], and 4 with previous surgery (S) and/or BA [Group 1B]. Abdominal CoA was present in 2 pts in Group IB. ST were primarily deployed in 5 pts [Group 11], all with previous S. Expanded balloon-ST diameters ranged from 10-18 mm, 14.2 mm. There was no difference in age or size among the 3 groups. *Results:*

Systolic Gradient (mmHg)				
Grp	Pre BA	Post BA	Pre ST	Post ST
IA	*51.7±10.3	19±15.2		1.5±2.3
IB	30.5±4.2	20.8±6		2.5±3.8
II	NA	NA	29.4±3.8	0.6±0.9
Diameter of Stenosis (mm)				
IA	*3±0.8	8.8±2.7		14.7±2.7
IB	5.8±2.6	6.8±2.6		10.7±1.8
II	NA	NA	7.8±3.1	14.1±2.5

Complications: Group IA: Aortic aneurysm (AA) diagnosed by spiral CT in 2 pts with 1 requiring S; redilation of ST after ST-wall separation in 1 pt. Group IB: 2nd ST placed for residual CoA in 2 pts. Group II: ST-sheath entrapment with vascular injury requiring S in 1 pt. Conclusions: 1) ST provided excellent relief of CoA gradients, regardless of site or previous S/BA. 2) In native CoA in older pts, tight stenosis is common with significantly larger gradients. BA with full expansion of ST may lead to AA. Serial, graduated dilation may decrease vascular injury and incidence of AA. 3) Spiral CT can detect AA, avoiding ST artifact and should be used in these pts. 4) Cautious optimism and close f/u are required!

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Comparative effectiveness of the Sideris and Amplatzer septal occlusion devices

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We compared the results of patch (Sideris adjustable buttoned) vs self-expanding stent (Amplatzer Septal Occluder) type devices in

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