Congenital anomalies associated with anorectal malformations – 16-year experience of one surgeon

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Abstract

Introduction: A retrospective study of 109 children with anorectal malformations (ARMs) was performed to find the incidence of associated congenital anomalies.
Material and methods: 109 consecutive children with ARMs were treated between 1992 and 2008. Analysis included sex, duration of pregnancy, body weight at birth and APGAR score, type of ARM and any associated anomalies. Anorectal malformation was classified according to Peña as either high, low or complex defect. All associated anomalies were classified in ten categories: urological, vertebral (incl. sacral bone), other skeletal, central nervous system, tracheoesophageal, cardiovascular, genital, gastrointestinal, miscellaneous and chromosomal abnormalities.
Results: The incidence of ARMs in this series was approximately 1 in 2300 live births. Additional anomalies were found in 66% of infants with ARMs. The most common associated defects were urinary tract (38.5%) and vertebral anomalies (33.9%). Trisomy 21 was observed in 3 children (2.8%). Multiple (two or more) associated anomalies were found in 40 out of 72 children with defects coexisting with ARMs (55.5%). VATER complex was observed in 13 children.
Conclusions: Children with ARMs have a high incidence of associated congenital anomalies. Neonates born with ARMs should be evaluated in search of anomalies of other organs and systems, because these additional defects are responsible for morbidity and mortality in patients with anorectal malformations.

Key words: anorectal malformations, associated anomalies, VATER complex.

Introduction

Anorectal malformations (ARMs) represent a spectrum of defects with different anatomical and physiological features [1]. Congenital anomalies associated with ARMs may develop in many other organs and systems, e.g. vertebral, cardiovascular, gastrointestinal, neurological, urogenital and skeletal, with their incidence ranging from 30 to 70%. Presence of multiple defects increases both morbidity and overall mortality rate in children with ARMs [2-5]. In consequence, a surgeon dealing with a newborn with an ARM is, in most cases, managing a baby with multiple congenital anomalies, and has to concentrate not only on the gastrointestinal tract, but also look for other defects to confirm or exclude their presence. Most reports in the literature concentrate on genitourinary tract and sacrum defects coexisting with ARM. Although the genitourinary tract and lumbosacral spine are the most frequent sites of associated defects, they rarely influence the mortality rate in this group of patients [6-9].

The aim of this study was to evaluate the incidence of anomalies of different organs and systems in a group of 109 consecutive children with ARMs and to compare their distribution between sexes and high and low ARMs.

Material and methods

Between April 1992 and December 2008, 109 children with ARMs referred to the Polish Mother's Health Centre (1992-1997) and the University Children's Hospital No. 4 in Łódź (1998-2008) were personally operated on by the author. Medical records of all patients were reviewed retrospectively and the recorded data included sex, duration of pregnancy, body weight at birth and APGAR score, type of ARM and any associated anomalies.

The type of ARM was determined on the basis of perineal appearance, the result of invertography and ultrasound of the perineum in newborns and distal colostography in children with created colostomy [10]. Anorectal malformation was classified according to Peña as either high (supra and translevator), low (infralevator) or complex defect [1]. Therefore, four subgroups of patients were formulated: boys with high ARMs, girls with high ARMs, boys with low ARMs and girls with low ARMs (Table I).

All associated anomalies were classified in ten categories after assembling all cases: urological, vertebral (incl. sacral bone), other skeletal, central nervous system (CNS), tracheoesophageal, cardiovascular, genital, gastrointestinal, miscellaneous and chromosomal abnormalities.

Lumbosacral spine and genitourinary tract were examined routinely in all patients as the most frequent sites of congenital defects associated with ARMs [6-9]. The evaluation of the sacral bone was based on the value of the sacroiliac ratio (SIR) calculated on the antero-posterior (a-p) radiogram of the pelvis [11]. It was done routinely during cystography, as part of a complex diagnostic examination of the urinary tract performed in every patient. Diagnostics began with US examination, followed by voiding cystography. If any defect was found, *i.v.* pyelography and renoscintigraphy were performed to evaluate the function of the kidneys and decide upon the type of treatment [12].

Other associated defects were diagnosed according to clinical presentation. Major anomalies were defined as those that have serious medical, surgical, or cosmetic consequences. Their incidence was compared between sexes and subgroups of high and low ARMs.

Statistical analysis consisted of χ^2 test with Yates and Fisher exact corrections.

Table I. Number of patients according to sex and type of ARM

Type of ARM	Sex		Total	χ^2 + Y
	M	F		
Low	32	44	76	
High	24	9	33	χ^2=7.45, p = 0.006
Total	56	53	109	

Y – Yates correction

Results

Incidence, perinatal data and sex

The approximate incidence of ARMs in the years 1991-97 in the population of Lodz province based on the presented group of patients and data obtained from the other paediatric centre (there are two in Lodz) was 1 : 2295 [13]. Fifteen children died in the neonatal period due to lethal associated anomalies; thus the mortality rate was 13.8%. They were included in the classifications and analysis.

The mean duration of pregnancy was 39.1 hbd, mean birth weight was 3111 g and mean Apgar score was 8.76. There were no significant differences in the examined parameters between subgroups of low and high ARMs. Fifteen newborns with ARMs who died in the neonatal period had duration of pregnancy significantly shorter (35.5 hbd), mean birth weight significantly lower (2385 g) and Apgar score significantly lower (5.3) than 94 babies who survived ($p < 0.001$).

In the analysed group of 109 children with ARMs there were 56 boys (51.4%) and 53 girls (48.6%); thus the sex ratio was M : F = 1.05 : 1.

Classification of ARMs according to Peña [1]

Out of 109 children low type malformations were found in 76 children (69.7%) and they were twice as frequent as high defects, observed in 33 children (30.3%). High ARMs occurred almost three times more frequently in boys than in girls ($p = 0.006$). Conversely, low ARMs prevailed in girls ($p = 0.006$) (Table I). The most frequent low ARM in boys was imperforate anus without fistula, representing 1/5 of all ARMs found in boys. Perineal fistula and vestibular fistula constituted 3/4 of all ARMs observed in girls. Of high defects, the most frequent was urethral prostatic fistula in boys and persistent cloaca in girls (Table II).

Associated anomalies

Anomalies of other organs and systems found in children with ARMs were categorized in ten groups (Table III).

A total of 158 associated anomalies were found in 72 children (66.1%) with ARMs. The remaining 37 patients (33.9%) had isolated ARM diagnosed. Overall, urinary tract anomalies were observed in 38.5% of patients with ARMs and together with vertebral defects, seen in 33.9% of cases, were the most common associated anomalies in the present

Table II. Anorectal malformations (ARMs) and their incidence in the studied group of children

Type of ARM	No. of patients	
Males	**56**	**51.4%**
Low	**32**	**29.4%**
– no fistula	11	
– midline raphe fistula	7	
– perineal fistula	6	
– urethral bulbar fistula	6	
– anal stenosis	2	
High	**24**	**22.0%**
– urethral prostatic fistula	11	
– no fistula	5	
– rectoanal stenosis	4	
– bladder neck fistula	3	
– rectal atresia	1	
Females	**53**	**48.6%**
Low	**43**	**39.4%**
– perineal fistula	21	
– vestibular fistula	18	
– vaginal fistula	2	
– anal stenosis	1	
– open cutaneous fistula	1	
High	**10**	**9.2%**
– persistent cloaca	4	
– vaginal fistula	3	
– no fistula	2	
– rectoanal stenosis	1	
Total	**109**	

series. Primary VUR (n = 14) and renal agenesis (n = 10) prevailed among urinary anomalies, while missing sacral and coccygeal vertebra (n = 22) and hemivertebra (n = 11) occurred most frequently among vertebral defects. Tracheoesophageal anomalies (n = 4, 3.7%), defects classified as miscellaneous (n = 6, 5.5%) and Down's syndrome (n = 3, 2.8%) were the least often observed malformations associated with ARMs.

Association of additional anomalies with high ARMs was observed two times more often than with low ARMs. Boys with ARMs had significantly higher risk of having coexisting defects than girls with ARMs ($p < 10^{-5}$). Also, boys with high ARMs had the highest risk of having associated anomalies (p = 0.002), compared with boys with low ARMs and girls with low and high ARMs. On the other hand, subjects with isolated ARMs more often had low ARM (p = 0.04) (Table IV).

Chi-square test was applied to compare data concerning anomalies associated with ARMs between sexes and between high and low ARMs (Table V). Boys with ARMs had significantly higher incidence of coexisting urinary tract, genital, cardiovascular and CNS anomalies. Children with high ARMs had significantly higher incidence of urinary tract, vertebral, genital, cardiovascular and CNS defects. Associated urological, vertebral and CNS anomalies occurred significantly more frequently in boys with high ARMs than in boys with low defects. On the other hand, girls had higher incidence of urinary tract anomalies coexisting with low ARMs and vertebral defects with high ARMs (Table V).

Multiple (two or more) associated anomalies were found in more than half of children with defects coexisting with ARMs (40/72 – 55.5%) (Table VI). Association of urinary and vertebral anomalies was observed most frequently in the examined group.

Following data in the literature I qualified patients to have VATER or VACTERL association if 3 or more of the constituting anomalies were present [14-16].

All components of VATER complex (vertebral defects, anal atresia, tracheoesophageal fistula with oesophageal atresia, and radial and renal anomalies) were found in one instance, four in 2 patients, and three elements in 10 children. VACTERL association (vertebral, anal, cardiac, tracheal, oesophageal, renal, and limb anomalies) was not observed in the presented case series.

Discussion

Anorectal malformations occur with relatively high frequency. The incidence of ARMs estimated by the author was approximately 1 in 2300 live births [13] and was within the incidence range reported by other authors [1, 2, 4, 5]. It is well known that congenital anomalies of multiple organs and systems are associated with ARMs, and that the presence of these additional defects determines and influences morbidity and mortality in this group of patients [2-5]. Anomalies coexisting with ARMs can be categorized as follows: malformation syndromes, malformation associations, malformation sequences, chromosomal abnormalities, and sporadic isolated anomalies.

I observed coexisting congenital anomalies in 66% of children with ARMs in my series, which is within the range of 30% to 70% incidence of associated defects reported in the literature [2, 4, 5, 17, 18]. The male to female ratio in the analyzed group was approximately 1.05 : 1, while that given by other authors ranged from 1.2 : 1 to 1.8 : 1 [2-5].

The regions most frequently affected by additional anomalies in my group of patients were the urinary system, vertebral column and genitals. I observed abnormalities in the urinary system in 38.5% and in genitals in 18.3% of patients with ARMs. Together the incidence of genitourinary anomalies in my case series was 56.8%, compared with the frequency in the literature ranging from 26 to 85% in patients with ARMs [1-3, 5-7, 17, 18]. Because of the high incidence of these associated abnormalities, evaluation of the

Table III. Associated anomalies regarding organ and system sites

Organ/System	Anomalies	Incidence				Total	Literature
		Low		High			
		M	F	M	F		
Isolated ARM		**9**	**17**	**4**	**7**	**37-33.9%**	**29-42%**
Urinary:		**8**	**10**	**21**	**3**	**42-38.5%**	**25-55%**
	VUR	3	7	3	1	14	
	Renal agenesis	2	2	5	1	10	
	Hydronephrosis	1	1	2	1	5	
	Urethral atresia	–	–	4	–	4	
	Polycystic kidney bilat.	1	–	2	–	3	
	Polycystic kidney unilat.	–	–	2	–	2	
	Dysplastic/aplastic kidney unilat.	1	–	1	–	2	
	Dysplastic/aplastic kidney bilat.	–	–	2	–	2	
Vertebral (incl. sacral bone):		**4**	**3**	**17**	**13**	**37-33.9%**	**7-38%**
	Missing sacral/coccyg. vertebra	2	2	10	8	22	
	Hemivertebra	2	1	5	3	11	
	Sacral agenesis	–	–	1	2	3	
	Sacrococcygeal tumour	–	–	1	–	1	
Genital:		**7**	**1**	**8**	**4**	**20-18.3%**	**8-30%**
	Cryptorchidism	2	–	4	–	6	
	Vaginal septum	–	1	–	3	4	
	Bifid scrotum	2	–	1	–	3	
	Hypospadias	2	–	1	–	3	
	Micropenis	1	–	2	–	3	
	Vaginal atresia	–	–	–	1	1	
Cardiovascular:		**5**	**1**	**8**	**1**	**15-13.7%**	**3.5-27%**
	VSD	1	–	2	–	3	
	ASD	1	–	2	1	4	
	TGA	–	–	2	–	2	
	Common AV canal	1	–	1	–	2	
	Tetralogy of Fallot	1	–	1	–	2	
	Complex defects	1	1	–	–	2	
CNS:		**1**	**–**	**8**	**3**	**12-11%**	**8-67%**
	Hydrocephalus	–	–	2	–	2	
	Microcephaly	1	–	1	–	2	
	Meningocele	–	–	1	–	1	
	Neurogenic bladder	–	–	4	3	7	
Other skeletal:		**3**	**3**	**4**	**1**	**11-10.1%**	**13-16%**
	Radial dysplasia	1	–	1	–	2	
	Missing ribs	1	1	2	–	4	
	Polydactyly/syndactyly	1	2	1	1	5	
Gastrointestinal:		**2**	**1**	**3**	**2**	**8-7.3%**	**5-10%**
	Duodenal atresia	1	–	1	1	3	
	Malrotation/nonrotation	1	1	2	1	5	
Tracheoesophageal:		**1**	**–**	**2**	**1**	**4-3.7%**	**6-11%**
	Oesophageal atresia with TEF	1	–	2	1	4	
Miscellaneous:		**1**	**3**	**1**	**1**	**6-5.5%**	**4-8%**
	CDH	–	1	–	–	1	
	Cleft palate	1	1	–	1	3	
	Omphalocele	–	1	1	–	2	
Chromosomal abnormalities:		**2**	**1**	**–**	**–**	**3-2.8%**	**3%**
	Down's syndrome (trisomy 21)	2	1	–	–	3	
	Total	**34**	**23**	**72**	**29**	**158**	

VUR – vesicoureteral reflux, VSD – ventricular septal defect, ASD – atrial septal defect, TGA – transposition of great arteries, CNS – central nervous system, CDH – congenital diaphragmatic hernia

genitourinary system in patients with ARMs is recommended by many researchers [4, 6, 7, 17-20]. I performed voiding cystourethrogram and ultrasound examination of the kidneys and bladder as a routine procedures in all patients with ARMs.

Vertebral anomalies including sacral bone defects were observed in 34% of the infants in the analyzed case series. The reported incidence of this type of anomaly in patients with ARMs ranges from 7 to 38% [3, 4, 7, 17, 18, 20]. Many authors recommend ultrasonography and radiography in evaluation of the vertebral column, and MRI in cases of abnormal findings on radiographs or ultrasound [4, 7, 19, 20]. In our institution the lumbosacral spine was evaluated on a radiograph performed during the voiding cystography, as part of routine management of patients with ARMs.

Cardiovascular anomalies were observed in 13.7% of babies with ARMs in my case series. Echocardiograms were performed as part of early diagnostics if the presence of cardiac defect was suspected [3, 4, 21]. Central nervous system anomalies were found in 11% of cases. Both severe cardiovascular and CNS anomalies influenced mortality rate in the analyzed group of patients.

The only chromosomal abnormality was trisomy 21, observed by me in three instances and confirmed by karyotypes. The association of Down syndrome with ARMs is well known and has been described in the literature [5, 22].

Among several syndromes described in the literature as being associated with ARMs are the following: Townes-Brocks, Johanson-Blizzard, Pallister-Hall, Currarino, cat's-eye, Down, Opitz, Zellweger, and FG syndromes [3, 5, 23]. None of these syndromes were observed in the presented group of patients.

VATER association, as the only malformation association, was observed in 13 cases of the examined group of patients. The expression of this association shows phenotypic heterogeneity.

None of my patients had any other malformation association or sequence reported as coexisting with ARMs, i.e. exstrophy of cloaca sequence, sirenomelia

Table IV. Incidence of associated anomalies regarding sex and type of defect in children with ARMs

Type of ARM	Sex		Total
	M	F	
Low:	**32**	**44**	**76**
isolated ARM	9	17	26
associated anomalies	23	27	50
High:	**24**	**9**	**33**
isolated ARM	4	7	11
associated anomalies	20	2	22
Total	**56**	**53**	**109**

Table V. Anomalies associated with anorectal malformations

Organ/System	Sex	χ^2 + Y	ARM	Total	χ^2	M	χ^2	F	χ^2
Urinary	M = 29	$\chi^2 = 4.0$	High	24	$\chi^2 = 21.3$	21	+Fe	3	+Fe
	F = 13	$p = 0.04$	Low	18	$p < 10^{-5}$	8	$p < 10^{-5}$	10	$p < 0.003$
Vertebral	M = 21	NS	High	30	$\chi^2 = 64.9$	17	+Fe	13	+Fe
	F = 16		Low	7	$p < 10^{-5}$	4	$p < 10^{-5}$	3	$p < 0.003$
Genital	M = 15	$\chi^2 = 4.4$	High	12	$\chi^2 = 8.6$	8	NS	4	NS
	F = 5	$p = 0.04$	Low	8	$p = 0.003$	7		1	
Cardiovascular	M = 13	+Fe	High	9	$\chi^2 = 5.7$	8	NS	1	NS
	F = 2	$p = 0.003$	Low	6	$p = 0.02$	5		1	
CNS	M = 9	+Fe	High	11	+Fe	8	+Fe	3	NS
	F = 3	$p = 0.009$	Low	1	$p < 10^{-5}$	1	$p < 0.003$	–	
Other skeletal	M = 7	NS	High	5	NS	4	NS	1	NS
	F = 4		Low	6		3		3	
Gastrointestinal	M = 5	NS	High	5	NS	3	NS	2	NS
	F = 3		Low	3		2		1	
Tracheoesophageal	M = 3	NS	High	3	NS	2	NS	1	NS
	F = 1		Low	1		1		–	
Miscellaneous	M = 2	NS	High	2	NS	1	NS	1	NS
	F = 4		Low	4		1		3	
Chromosomal	M = 2	NS	High	–	NS	–	NS	–	NS
	F = 1		Low	3		2		1	

Y – Yates correction, FE – Fisher exact correction, NS – not significant

Table VI. Multiple association of anomalies coexisting with anorectal malformations

Associated anomalies found in one patient	No. of children	
One	32	
Two	14	
Three	13	(10 – VATER)
Four	6	(2 – VATER)
Five	7	(1 – VATER)
Total	**72 (66.1%)**	

sequence, caudal regression sequence, Klippel-Feil sequence, OEIS complex (omphalocele, exstrophy, imperforate anus, spinal defects), and CHARGE (coloboma, hearing deficit, anal atresia, retardation of growth, male genital defects, endocardial cushion defect) association [3, 23].

In conclusion, the results of the performed study revealed that 66% of children with anorectal malformations had additional anomalies in other organs and systems. The most frequent sites of coexisting anomalies were the urogenital system and vertebral column, the lumbosacral segment in particular. High ARMs were more frequent in males and were also more frequently associated with other congenital anomalies than low ARMs. Associated urological, vertebral and CNS anomalies occurred significantly more frequently in boys with high ARMs than in boys with low defects and in girls.

Taking into consideration all of the above, it should be stated that it is necessary to evaluate neonates born with ARMs in search of anomalies of other organs and systems, especially those that are the most frequent sites of anomalies associated with ARMs, i.e. the urogenital, vertebral and cardiovascular systems. It is important because these additional defects are responsible for morbidity and mortality in patients with anorectal malformations.

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