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GASTROINTESTINAL PERFORATION FOLLOWING BLUNT ABDOMINAL TRAUMA
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ABSTRACT

Objective: **To highlight the pertinent management problems of bowel perforation following blunt abdominal trauma.**

Design: **A prospective descriptive study.**

Setting: **Hospital-based cohort over a nine year period in Jos University Teaching Hospital, Jos, Nigeria.**

Subjects: **A total of 23 patients with bowel perforation out of 8,970 trauma victims with a mean age of 28.5 years.**

Intervention: **Exploratory laparotomy, drainage of septic peritoneal fluid and wound saline lavage and closure of perforations were performed in all the 23 patients with clinical features and imaging signs suggestive of bowel perforation following blunt abdominal trauma. Femoral fractures were splinted and tube thoracostomy were carried out in four and two patients respectively.**

Main outcome measures: **There is an apparent delay in presentation and diagnosis of traumatic bowel perforation following blunt abdominal trauma. Signs of peritoneal sepsis remain the most consistent findings in our environment. The morbidity and mortality following blunt abdominal trauma and bowel perforation are high because of established peritonitis. Delayed presentation or large leakage of bowel content into the peritoneal cavity and the attendant ease with which peritonitis develops in the latter are factors responsible.**

Results: **Delayed presentation (mean 3.05 days) was observed in seven of 23 patients. Eight patients had concomitant injuries; two to the head, four had right femoral fracture and two blunt chest injury. Features of peritonitis were present at initial evaluation in 19 patients. Seventeen patients were victims of motor vehicle accident. Radiological evidence of perforation *(pneumoperitoneum)* was present in only two of four patients with difficult diagnosis. Free peritoneal fluid without solid organ injury was detected in two patients with ultrasound. Diagnostic peritoneal lavage was, therefore, not used in any of our patients. The mean time from admission to laparotomy was six hours. Sites of perforations were: stomach (2), jejunum (9), ileum (8), jejunum/ileum (2) and colon (2). Sepsis originating from the perforated bowel was responsible for mortality in our patients who died in the perioperative period with concomitant injury playing significant role in three of 11 patients with such injuries.**

Conclusion: **Peritonitis following a bowel perforation after blunt abdominal trauma is often present at the time of presentation and diagnosis is usually made. In the few doubtful cases, often in patients presenting soon after trauma, X-ray and trans-abdominal ultrasonography will assist in making a diagnosis. Delayed presentation still accounts for a high mortality in bowel perforation following blunt abdominal trauma.**

INTRODUCTION

Injuries especially as a result of blunt trauma, now constitutes one of the major causes of death in our society. The frequency of trauma to the abdomen may be increasing in almost geometric proportion as the number and speed of highway vehicles, civil unrest and terrorist attack rises (1-3).

In some cases of these abdominal injuries, blunt trauma of the gastrointestinal tract are occasionally found. Perforations of the gastrointestinal tract compared to solid organ injuries, are a relatively infrequent sequelae of blunt abdominal trauma (1-4). The difficulty with these injuries lies in establishing the diagnosis (6-8).

Gastrointestinal tract lesions following blunt abdominal trauma (BAT) frequently remained undetected or are diagnosed too late despite advance in medical imaging with techniques such as sonography, computer tomography and magnetic resonance imaging (6,8). Though peritoneal lavage has a high diagnostic sensitivity for gastrointestinal perforation (GIP) compared to other diagnostic modalities, nonetheless it does not allow reliable prediction of injuries of the gastrointestinal tract (9). Consequently, serious complications such as peritonitis and even cases resulting in death are sometimes encountered.

The present trend toward conservative management of haemodynamically stable trauma patients may be increasing the risk of delay in the diagnosis of traumatic gastrointestinal perforation following BAT. The study looked at gastrointestinal perforation following BAT and highlights pertinent management problems in a centre in a developing country.

MATERIALS AND METHODS

Trauma admissions between May 1994 and May 2002 at the Jos University Teaching Hospital (JUTH) in consecutive patients presenting with features of peritonitis and suspected to have gastrointestinal perforations caused by blunt abdominal trauma formed the basis of our report. Those in whom bowel perforations were not found at surgery to be responsible for peritoneal irritations were excluded from the study. Data collected were mechanisms of injury, results of admissions and serial clinical examinations, results of radiologic imaging, associated injuries, operative findings, treatment and outcome. Follow up was obtained on all patients. The results were then analysed.

RESULTS

A total of 8,970 trauma cases were seen during the period under consideration. Twenty three of them had gastrointestinal perforation. Their ages ranged from one and a half years to sixty years with a mean of 28.5 years. All were males. The age distribution is shown in Table 1.

Table 1

Demographic data of the patients

Age in years	Total
Upto 10	4
11–20	4
21–30	6
31–40	5
41–50	1
51–60	3
Total	23

Mechanism of injury: Seventeen patients were involved in road traffic accidents and in one, the wheel of a car went over his abdomen. One patient had a kick to the abdomen at play. A blow to the abdomen with a piece of wood accounted for four cases; two at play and the other two during a fight. A falling gear box on the abdomen of an automobile mechanic was responsible for one case. Fifteen of these patients had symptoms and signs confined to only the abdomen. Injuries to multiple organ systems were present in eight patients all of whom were victims of road traffic accidents. A combination of blunt abdominal injury and head injury were present in two patients; abdominal injury and right femoral fracture in four patients and abdominal injury and chest injury with infected left haemothorax was present in two patients.

Table 2

Mechanism of injury, number of organ systems involved and mortality

Mechanism of injury	No. of patients	Number of organ system involved				Mortality	Delayed diagnosis
		Single	Multiple				
		Abdomen	Head, neck & abdomen	Long bones/ abdomen	Abdomen/ chest		
Road traffic accidents (RTAs)	17	9	2	4	2	9	5
Kick to the abdomen (feet)	1	1	0	0	0	0	0
Blow to the abdomen (wood, fist, etc.)	4	4	0	0	0	2	2
Falling object	1	1	0	0	0	0	0
Total	23	15	2	4	2	11	7

Results of clinical evaluation and radiologic imaging: The symptoms were severe enough to allow presentation soon after the accident in sixteen (69.5%) patients while it was delayed in seven patients (30.4%). Diagnosis of peritonitis was obvious at presentation in twelve (75%) of these patients and in the remaining four (25%) diagnosis of peritonitis was not certain on admission. These four patients had erect chest X-ray and in two of them air was present under the diaphragm. Abdominal sonography in two of the four patients with no gas under the diaphragm revealed fluid in the peritoneal cavity, no solid organ injury, and dilated fluid loaded loops of bowel exhibiting no peristalsis. We did not, therefore, proceed to do diagnostic peritoneal lavage in these patients who had exploratory laparotomy based on the above findings. Four-quadrant abdominal tap done at presentation in the four doubtful cases were negative.

All the seven of 23 patients presenting late did so within an average of three days after the trauma and had features of peritonitis and septicaemia. They had abdominal pain at the time of trauma that they thought was minor and, therefore, ignored. A patient with femoral fracture had been with a traditional bone setter. All the seven patients presenting late and 12 of those presenting on the day of trauma had cardiovascular instability with low blood pressure and a pulse of over 100 beats per minute.

Operative findings and treatment: Our patients with clinical and radiological signs suggestive of bowel perforation were resuscitated and offered exploratory laparotomy. General anaesthesia was used. Established peritonitis with loculated abscesses were the main features in those presenting late while large sequested peritoneal fluid and mild to moderate blood loss giving it a dark-brown colour were the features in early presenters. The bowels were generally not inflamed in this latter group. The ileum alone was perforated in eight patients; ileum and jejunum in two; jejunum alone in eight; stomach two and colon two. Septic peritoneal exudates was found in both sides of the scrotum between the layers of the tunica vaginalis that communicated freely with the peritoneal cavity in four. These patients did not have a hydrocoele or inguinal hernia before the accident.

Table 3

Regional distribution of gut and other intra-abdominal visceras involved

Region of the gut/visceras involved	No.
Ileum	8
Jejunum/ileum	2
Jejunum	8
Stomach/Liver lacerations	2
Colon/Spleen	2

The septic peritoneal exudates were evacuated, edges of perforations excised and primary closure done. Peritoneal cavities were copiously lavaged and closed. Partial closure of skin and subcutaneous tissues were done after a lavage with saline. One patient had a tube thoracostomy. All femoral fractures were initially treated by skeletal traction and ultimately sent to the orthopaedic surgeons for definitive treatment. Head injuries were mild and managed conservatively with good outcome.

Morbidity/Mortality: Two patients with ileal perforations had faecal fistula while superficial wound infection complicated six procedures. One patient with ileal faecal fistula required a second surgery for the construction of another anastomosis. Both fistulae closed while the superficial wound infections were treated successfully with antibiotics and daily wound dressing.

We recorded a total of eleven deaths that occurred within an average of 25 hours post surgery. Three belong to the group of seven patients with delayed presentation who had established peritonitis and septicaemia. Eight of the remaining deaths were in patients who presented on the day of accident and diagnosis of peritonitis was certain at presentation. Three of the eight patients had other organ system injuries following road traffic accident in addition to bowel perforation.

DISCUSSION

Gastrointestinal perforation with spillage of bowel contents into the general peritoneal cavity quite often manifest with features of peritoneal irritation and septicaemia. Diagnostic difficulty does not usually exist. However, in some few categories of patients, particularly those with blunt injury to the abdomen, diagnosis may be difficult resulting in delayed treatment, poor surgical outcome and sometimes avoidable deaths. Most of our patients were relatively young males, a reflection of a mobile age group exposed to a relatively increased risk of trauma commonly due to road traffic accidents (RTAs).

One-third of our patients did not present to the hospital until after an average of three days with advanced peritonitis. Reasons put forward to explain such delay include:

(i) Relatively feeble initial peritoneal irritation induced by the nearly neutral intestinal content particularly those with perforation between the duodeno-jejunal flexure and the ileocaecal junction (1).

(ii) In small perforations the mucosa may prolapse through the hole and partly seal it making early signs misleading (1,2).

(iii) The entity of a delayed perforation caused by an evolving injury. These patients have an initial contused bowel wall at the time of trauma that ultimately gives way after a variable period with resultant peritonitis (10).

Abdominal pain, the usual symptom indicating abdominal injury was not severe in seven of 23 patients and therefore the patient did not seek hospital care soon after the injury most probably due to the above reasons. These victims resorted to taking regular analgesics (Paracetamol) to relieve what they thought were minor symptoms with consequent delayed presentation. Enlightenment campaign directed at the medical and general public should be encouraged to raise the awareness that no abdominal symptom is minor to be ignored and that initial hospital check-up is necessary after significant trauma to the abdomen to avoid missing potentially serious injuries. However, where multiple perforations or large perforations of the gut were noted at surgery, the peritoneal spillages were also large and associated with early peritonitis prompting early presentation as it was the case in the 14 patients (87.5%) who came to the hospital soon after trauma to the abdomen.

Four of sixteen patients seen on the day of trauma (RTA) could not be established to have significant abdominal hollow visceral injury. Close surveillance supplemented by radiological investigations and timely surgical intervention saved the lives of the four patients. The presentation in these four patients indicates that initial clinical and radiological evidences of bowel perforation can be misleading and reliance on such indicators may result in significant diagnostic delay. However, we did find plain X-ray and abdominal sonography useful in establishing diagnosis in these four patients and therefore diagnostic peritoneal lavage which has a high diagnostic sensitivity for hollow visceral perforation compared to other diagnostic modalities was not employed in the four cases with uncertain bowel perforation. The value of this method in the diagnosis of blunt abdominal trauma and possible lesions of the gastrointestinal tract, though not absolute, is indisputable and clinician should adopt this technique where diagnosis is in doubt (11), particularly in centres that lack X-ray facilities and other modern imaging techniques. Although, abdominal sonography is becoming increasingly important in the diagnosis of abdominal trauma, lesions of the gastrointestinal tract frequently remained undetected or are diagnosed too late where this method of examination is used exclusively (8). However, free peritoneal fluid without solid organ injury detected on ultrasound in a patient with

trauma to the abdomen will suggest a significant injury requiring exploration.

Three deaths were the result of sepsis originating from perforated bowel occasioned by delayed presentation and treatment. Severe primary intra-abdominal visceral injury, hypovolaemia and sepsis as observed previously (12) were also factors related to deaths in the remaining eight patients who presented on the day of trauma. Large sequestration of fluid in the peritoneal cavity was common operative findings. These combinations of risk factors, particularly sepsis and hypovolaemia put these patients in a non-ideal condition for surgery. Under such circumstances a quick surgery limited to containing continuous soilage and evacuation of pus becomes necessary. An anaesthetic technique utilising local infiltration and sedation (13) with adequate transfusion of blood to maintain blood pressure seems necessary. This was employed in some of our patients with good outcome.

Postoperative complications were limited to faecal fistula, pelvic abscess and superficial wound infection. Thorough lavage of peritoneal cavity and wound allowing septic fluid to exude from wound before final closure are essential.

Blunt abdominal trauma with bowel perforation is occasionally difficult to diagnose particularly in those with multiple injuries or evolving peritonitis in our environment (16). Thorough clinical assessment complimented with investigative modalities such as X-ray and ultrasonography will help to resolve this occasional diagnostic conundrum most times. Where these investigations cannot be carried out, especially at the level of the district hospitals, diagnostic peritoneal lavage (DPL) will reveal a significant intraperitoneal injury (11). Patients with bowel perforation following blunt abdominal trauma present late with established peritonitis. Very few presenting early with doubtful diagnosis of significant bowel injury will require additional investigations to confirm its presence. Late presentation still account for a high mortality in bowel perforation after BAT.

Provision of accessible and affordable health care facilities and health education are measures that will encourage accident victims to seek help in hospital rather than in non-orthodox health centres. These above measures will certainly reduce morbidity and mortality directly linked with late presentation in patients with blunt abdominal trauma.

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DIAGNOSIS, MANAGEMENT AND OUTCOME OF CONGENITAL HEART DISEASE IN SUDANESE PATIENTS
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DIAGNOSIS, MANAGEMENT AND OUTCOME OF HEART DISEASE IN SUDANESE PATIENTS

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ABSTRACT

Objectives: **To describe the diagnosis, management and outcome of patients with congenital heart disease seen at Sudan Heart Centre.**
Design: **A prospective follow up of all patients diagnosed as congenital heart disease.**
Setting: **Sudan Heart Centre.**
Subjects: **All children and adults with congenital heart disease seen at Sudan Heart Centre by one paediatric cardiologist from July 2004 to June 2005.**
Results: **Five hundred and twenty two patients were evaluated, 435 had abnormal hearts. The median age was 48 months (one day to sixty five years). Congenital heart disease constituted 87% and acquired heart disease and rhythm disorders 13%. The frequency of the different cardiac heart disease was described and in general did not differ from that reported in the literature except for Ebstein anomaly which was noted to be four times more frequent than reported. Cardiac catheterisation was done for 81 patients, for diagnosis in 61 (75%) and for intervention in 20 (25%) patients. Balloon dilatation, atrial septostomy septal defect and patent ductus arteriosus closure with the help of a visiting team, the success rate for interventions was 95%. Surgery was done for 125 patients. Seventy three operations were done by the local team and 52 by the visiting team. The 30 day operative mortality was 8.3%.**
Conclusion: **Paediatric cardiac service in Sudan in echocardiography and cardiac catheterisation is growing. Cardiac surgical results are comparable to the literature.**

INTRODUCTION

Sudan Heart Centre (SHC) is a cardiac referral centre established in the year 2000 as one of the first few centres of its kind in Sudan. In the initial period till the year 2001 the service was delivered to children by adult cardiologists. Paediatric cardiology was first started in 2001 by one part-time paediatric cardiologist. A paediatric cardiac surgeon joined the centre in 2002. In July 2004 a full-time paediatric cardiologist joined the centre and established the paediatric catheterisation service. The purpose of this study was to review the diagnoses (echocardiographic and cardiac catheterisation), management (medical, catheter based and surgical) and its outcome for children seen at the SHC.

MATERIALS AND METHODS

All paediatric patients and adults with congenital heart disease (CHD) seen at SHC from July 2004 to June 2005 were included in the study. Patients were evaluated clinically and by echocardiography. Cardiac catheterisation was done when indicated.

Echocardiography: A complete 2-dimensional /Doppler echo study was done for each patient using MEGAS (Esaote) machine. A standard

technique (segmental approach) using the four echo views (subcostal, parasternal long and short and suprasternal) was applied. Sedation with chloral hydrate (50mg/kg/dose) was used in infants who needed detailed initial and/or preoperative studies. A written report with printed pictures was initially used for documentation but recently a digital archiving system was established and patients going for surgery had their echo studies recorded digitally.

Cardiac catheterisation: Indications for cardiac catheterisation were:

(i) Diagnosis of anatomical lesions not well delineated by echo.
(ii) Diagnosis of haemodynamic abnormalities.
(iii) Treatment of anomalies amenable to interventional catheterisation.

Cardiac catheterisation was done as day case for diagnostic purposes in older children. Infants and children undergoing interventions were admitted overnight for monitoring. General anaesthesia was used for the latter group of patients while for the first group ketamine was used for sedation. Interventional septal defect occlusion was done by a visiting team, while pulmonary valve dilatation, atrial septostomy and patent ductus arteriosus occlusion was done by the local team.

Cardiac surgery: Patients selected for surgery were discussed with the cardiac surgeon in a joint meeting. Our policy is to perform definitive intracardic repair of congenital heart defects (where indicated) in patients weighing more than six kilograms; below six kilograms our local surgical team performs palliative procedures and definitive closure of patent ductus arteriosus and coarctation of aorta. Open heart surgery for children weighing below six kilograms and complex repairs were done by a visiting team lead by a paediatric cardiac surgeon.

Statistical methods: Patients' data were entered into an SPSS computer program and frequency tables were generated.

RESULTS

In the study period 522 patients were evaluated. The age ranged from one day to 65 years with a median of 48 months. Male to female ratio was 1.3:1. Four hundred and thirty five patients (80%) had abnormal cardiac examination and 87 (20%) were normal. CHD constituted 378 (87%) and acquired heart disease and rhythm disorders 57 (13%). Rheumatic heart disease was diagnosed in 36 patients (8.2%).

Diagnosis of congenital heart disease: Table 1 shows the frequency of CHD diagnosed on echo and Table 2 the frequency of acquired heart disease and rhythm disorders. The most common acyanotic anomalies were ventricular septal defect (16.1%), atrioventricular septal defect (8.6%), atrial septal defect (6.2%) and patent ductus arteriosus (4.6%). Tetralogy of Fallot was the most common cyanotic anomaly (17.7%) followed by transposition of great arteries (6.6%) and tricuspid atresia (3.2%). Rhythm disorders included three patients with congenital atrioventricular block and two patients with supraventricular tachycardia.

Cardiac catheterisation: A total of 81 cardiac catheterisations were done in the study period. Table 3 shows the indications for cardiac catheterisation and Table 4 the outcome and disposition of patients who underwent catheterisation. Common indications for diagnostic catheterisation were Tetralogy of Fallot to delineate the pulmonary artery anatomy in 16 (23%) patients and large ventricular septal defect to measure pulmonary vascular resistance in 12 (15%) patients.

In two patients the cardiac catheterisation diagnosis was different from echo. In the first patient catheterisation corrected the echo diagnosis of total anomalous pulmonary venous return to the diagnosis of transposition of great arteries with normal pulmonary venous return. The second patient had double outlet right ventricle on echo and catheterisation revealed that there was, in addition, severe pulmonary valve stenosis. Twenty patients

Table 1

Congenital heart disease diagnosed on echo

Lesion	No.	(%)
Ventricular septal defect	68	16.1
Small	22	
Large	46	
Atrial septal defect	27	6.2
Secundum	24	
Sinus venosus	2	
Unroofed coronary sinus	1	
Patent ductus arteriosus	20	4.6
Small	2	
Large	18	
Atrioventricular septal defect	37	8.6
Partial	16	
Complete	10	
Unbalanced	9	
With pulmonary valve stenosis	2	
Pulmonary valve stenosis	26	6
Aortic stenosis	6	1.3
Valvular	1	
Sub-valvular	4	
Supra-valvular	1	
Coarctation of aorta	3	0.7
Anomalous pulmonary venous drainage	4	0.9
Ebstein anomaly	12	2.1
Tetralogy of Fallot	77	17.7
Tetralogy of Fallot with absent pulmonary valve	2	
Transposition of great arteries	29	6.6
Intact ventricular septum	8	
Ventricular septal defect	10	
Ventricular septal defect /pulmonary stenosis	11	
Corrected transposition of great arteries	6	1.4
Tricuspid atresia	14	3.7
With ventricular septal defect	3	
With ventricular septal defect/ pulmonary valve stenosis	10	
With transposition of great arteries	1	
Truncus arteriosus	8	1.8
Double inlet left ventricle	4	0.9
Double outlet right ventricle	12	2.7
Subaortic ventricular septal defect	5	
Subpulmonary ventricular septal defect	4	
Doubly committed ventricular septal defect	2	
Non-committed ventricular septal defect	1	
Pulmonary atresia with ventricular septal defect	12	2.8
Isometric heart	7	1.6
Mitral valve anomalies	3	0.7
Total	378	100

Table 2

Acquired heart diseases and rhythm disorders

	No.	(%)
Rheumatic heart disease	36	63.15
Mitral regurgitation	17	47.5
Mitral stenosis	4	10.9
Aortic regurgitation	4	10.9
Mitral and aortic regurgitation	11	30.7
Cardiomyopathy	7	12.28
Pulmonary hypertension with no CHD	6	10.52
Tumours/miscellaneous	3	5.2
Rhythm disorders	5	8.7
Total	57	100

Table 3

Indications for cardiac catheterisation

Indication	No.	(%)
Preoperative assessment	50	61
Postoperative assessment	8	10
Intervention	20	25
Other	3	4
Total	81	100

Table 4

Outcome of cardiac catheterisation

Outcome measure	No.	(%)
Suitable for corrective surgery	26	32
Suitable for high risk surgery	10	12
Suitable for palliation	9	11
Not suitable for surgery	6	7
Successful intervention	19	23
Unsuccessful intervention	1	2.5
For re-do surgery	5	6
Conservative treatment	4	5
Insufficient data	1	1.2
Total	81	100

underwent interventional catheterisation including eleven cases of device occlusion (six patients with patent ductus arteriosus, three with atrial septal defect and two with ventricular septal defects). These device occlusions were done in SHC with the help of a visiting team. Other interventions were pulmonary valve dilatation (n = 6) and balloon atrial septostomy (n = 3). One patient had an unsuccessful trial of balloon dilatation for critical pulmonary valve stenosis. This was a syndromic infant with hypoplastic pulmonary arteries where we could not place the exchange wire in the distal pulmonary

artery branch. Complications of catheterisation included one mortality in a ten year old boy with pulmonary atresia and ventricular septal defect with major aortopulmonary collaterals who had multiple cerebrovascular accidents. His oxygen saturation before the procedure was 40% and he developed cardiac arrest with induction of anaesthesia. Two patients developed respiratory depression needing intubations and two patients had minor bleeding.

Outcome: Table 4 shows the outcome of patients who had cardiac catheterisation, Table 5 shows the overall outcome of patients, Table 6, the outcome of patients who had surgery and Table 7, the details of operations done by the local surgical team. Out of one hundred and eighty one patients referred for surgery, only one hundred and twenty four were operated on. Seventy two operations were done by the local team and fifty two by the visiting team. The local surgeons performed fifty eight corrective intracardiac procedures and fourteen closed procedures of which six were palliative. The most common open heart operations were 20 complete repair of Tetralogy of Fallot and 15 ventricular septal defect closure; three of the ventricular septal defect cases had additional procedures: one aortic valve replacement for severe aortic regurgitation, one mitral valve repair for an isolated anterior mitral valve cleft and one relief of pulmonary stenosis in a patient with corrected transposition of great arteries/pulmonary valve stenosis. The median weight was 18.75 kgs (range = 3 – 75 kgs) and the median age was eight years (range = 0.4 – 48 years). The total operative mortality was six (8.3%). Of these, five cases were corrective heart procedures: one Tetralogy of Fallot repair, three complex ventricular septal defect closures and one atrioventricular septal defect/pulmonary stenosis repair while one patient had a palliative operation (Modified Blalock-Taussig Shunt). For the visiting team the median age was 19.8 months (range = 1 month – 14 years) and the median weight was 7.1 kgs (range = 3 – 45). The mortality rate was nine (17.3%), seven were open heart procedures and included one transposition of great arteries with abnormal coronary anatomy, two obstructed total anomalous pulmonary venous drainage, one of them was associated with transposition of great arteries, one atrioventricular septal defect with Tetralogy of Fallot, one Tetralogy of Fallot with small pulmonary artery branches, one huge patent ductus arteriosus with pulmonary stenosis in a three kilogram infant, conduit change for a child with repaired truncus arteriosus. The two closed cases included one modified Blalock-Taussig Shunt and one complex Glenn procedure in an infant with isomeric heart.

Table 5

Outcome of patients with heart disease

Outcome	No.	(%)
Medical treatment	25	6.7
Corrective surgery	96	25.3
Palliative surgery	28	7
Catheter treatment	19	5
Inoperable	39	10.3
Late	21	5.1
Complex	18	6.2
Elective surgery	13	3.5
No treatment needed	29	8
Awaiting surgery	56	15
Expired	12	3.2
Unknown	61	17
Total	378	100

Table 6

Outcome of surgery for congenital heart disease

Surgery	No.	No. of deaths	(%) Mortality
Local team			
Open heart	58	5	8.6
Closed heart	14	1	7
Total	72	6	8.3
International team			
Open heart	38	7	18.4
Closed heart	14	2	14
Total	52	9	17.3

Table 7

Operations for congenital heart disease done by the local team

Type of Surgery	No.
Tetralogy of Fallot repair	20
Ventricular septal defect closure	15
Atrioventricular septal defect repair	6
Patent ductus arteriosus closure	7
Modified Blalock-Taussig Shunt	5
Secundum atrial septal defect closure	3
Secundum atrial septal defect / Pulmonary stenosis repair	3
Relief of subaortic aortic stenosis	4
Partial anomalous pulmonary venous drainage (two with sinus venous atrial septal defect)	4
Ascending aorta to pulmonary artery shunt	1
Relief of supra-valvular aortic stenosis	1
Relief of pulmonary stenosis	1
Pulmonary artery band	1
Permanent pacemaker insertion	1
Total	72

DISCUSSION

Management of children with heart disease is expensive as it needs specialised personnel and equipment. Working in developing countries where resources are limited and trained personnel scanty is a real challenge.

Few studies were published about the incidence of congenital heart disease detected by echocardiography in Sudan. El Hag (1) looked at 179 patients from 1991-1993 and found that CHD constituted 56% and rheumatic heart disease 39%. In Sudan, until the year 2001 echocardiography for children used to be done by adult cardiologists which leads to many limitations as the standard echo methodology (segmental approach) and nomenclature for congenital heart disease were usually not applied. During our study period we reviewed 40 echocardiograms for CHD done by adult colleagues and the diagnosis was incorrect in 45%, and incomplete in 30% of patients. Only in 25% the diagnosis was accurate and in all of these patients the diagnosis was either a ventricular or atrial septal defect (unpublished data), findings that are consistent with that of Stanger *et al* and Ward *et al* (2,3). In this study we described nineteen echo diagnoses with their subdivisions and their frequencies, many of these lesions had not to our

knowledge been investigated in Sudan. The frequency of most CHD did not differ from that published in the literature. However, for Ebstein anomaly we found a frequency of 2.1%, more than four times the reported frequency of 0.5% in the western literature (4).

Rheumatic heart disease continued to be the leading cause of acquired heart disease in our region, a prevalence of 3/1000 was reported in Sudan in 1992 (5). Compared to El Hag (1) who reported a frequency of rheumatic heart disease of 39%, our frequency (8.2%) is much less which might reflect some improvement in socio-economic standards. Of the seven patients with cardiomyopathy, two had non-compaction of the ventricular myocardium; a cardiomyopathy that we recently reported in a large series in Saudi Arabia and we think is largely under-diagnosed (6).

Indications for cardiac catheterisation did not differ from literature. Catheterisation corrected echo diagnosis only in two patients indicating the reliability of echo even for complex anomalies. Interventional catheterisation was first started by the adult cardiologist then taken over by the paediatric cardiologist. Visiting teams then helped starting a programme for device closure of atrial and ventricular septal defects and ductus arteriosus. Patent ductus arteriosus and atrial septal defect closure are being done but ventricular septal defect closure is a technically demanding procedure and is not planned at this time by the local team. Although the cost of these devices is high (2-3000 US Dollars) it is still comparable to the cost of surgery and non-surgical closure is now requested by many families.

Only 69% of patients requiring surgery were operated on indicating a long waiting period which is directly proportional to the socio-economic status of the family. The total cost of surgery (4000 US Dollars) is too high for many families especially those with rheumatic heart disease. Funds had been raised that could mostly pay 50% of the cost. On the other hand 5% of our patients presented when they were already inoperable. This is not unexpected in a country where paediatric cardiac services just started but should alert the general paediatricians about the importance of early diagnosis.

The institutional 30 day operative mortality of 8.3% for congenital heart operations is consistent with figures reported by Jenkins and Gauvreau (7) of 2.5% to 11.4% (median, 5.6%) for unadjusted mortality in twenty two large institutions in the United States. The patients who died were all in risk category 2; the risk-adjusted mortality for the latter category was 0% to 8.8% (median, 2.5%) as reported by Jenkens and Gauvreau (7) thus yielding an acceptable mortality for our patients.

The visiting team helped to treat many children with small weight and do complex repairs like Rastelli repair, Ross-Kono procedure, arterial and atrial switch operations. In addition there was significant consolidation of the experience of our intensive care staff with management of this group of children. The relatively high mortality of the international team is directly related to the complexity of lesions of the patients who died. These operations were all done during three ten-day visits with the rate of two to three operations per day which added to the postoperative management difficulties.

In conclusion, we managed to consolidate the service of paediatric cardiology at the SHC both in echocardiography and cardiac catheterisation. We can confidently perform definitive intracardiac repair of the most common congenital cardiac defects and palliate the more complex congenital cardiac defects in the well selected patients.

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