Case Series	
	
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Title	**CLINICAL PROFILE AND SURGICAL OUTCOMES OF NEONATES WITH DUODENAL ATRESIA: A RETROSPECTIVE STUDY FROM A TERTIARY CENTRE, SOUTH -EAST, NIGERIA**
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Keywords

Congenital intestinal obstructions, duodenal atresias, Kimura's duodenoduodenostomy, prematurity, VACTERL

Abstract

Background

Duodenal atresia is a congenital gastrointestinal anomaly requiring prompt surgical intervention. Globally, duodenal atresia is the most common form of intestinal atresias. In Nigeria however, it is second to jejunoileal atresias. This study aimed to describe the clinical profile and surgical outcomes of neonates with duodenal atresia in a Nigerian tertiary hospital and to identify factors affecting outcomes.

Patients and Methods

A 10-year retrospective review of neonates managed for duodenal atresias at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria. Data were extracted from the case notes and theatre records and analysed with SPSS version 27.

Results

Twenty-seven neonates were reviewed, with a male-to-female ratio of 1.7:1. The mean age at presentation was 6 days.Vomiting (100%), fever, and jaundice were common presenting symptoms. Prenatal diagnosis was made in only in 7.4% of cases. Type I duodenal atresia and post-ampullary obstruction were the most common pathologies. Associated anomalies included malrotation of the gut, spinal bifida, and VACTERL. Kimura's duodenoduodenostomy was the primary surgical procedure. The post-operative mortality rate was 37%, with prematurity significantly associated with poor outcome (p=0.016).

Conclusion

Duodenal atresia management in our setting is challenging, with high post-operative mortality. Prematurity and absence of prenatal diagnosis contribute to poor outcomes. Improving prenatal diagnosis and neonatal care with provision of Neonatal intensive care Units (NICU) may
Improve outcomes.

Introduction

Intestinal obstruction is a common surgical emergency encountered in the newborn with notable causes attributed to intestinal atresias, anorectal malformation and hirschsprung's disease.[1]

Intestinal atresia is found be a leading cause of the neonatal intestinal obstruction with incidence ranging from 1 in 1500 to 1 in 330 newborns[2,3]. Jejuno-ileal atresia is identified as the most common in Nigeria closely followed by duodenal atresia and colonic atresia.[4,5,6]

Outcome of surgical management of intestinal atresias in developed countries has remarkably improved over the past decade owing to the increased prenatal diagnosis, early presentation, availability of neonatal parenteral nutrition and intensive care unit with specialized pediatric intensivist and nurses. However, the outcome in developing nations has remained low. [7]

Congenital duodenal obstruction can be complete or partial resulting from problems of development of the duodenum at embryogenesis. It is postulated that the main problem with this condition is failure at recanalization of the luminal core of the

duodenum leading to either atresia or stenosis. Duodenal atresia is a congenital defect of the duodenum resulting as complete obstruction of the lumen. [8,9]

Globally, it is the most common form of intestinal atresias however it is only second to jejunoileal atresia in Nigeria. It accounts for approximately 1 in 5000 – 10, 000 live births with incidence showing male preponderance over females.[7, 10]. Close to half of affected children have other congenital anomalies including Down's syndrome in about 30% and others including congenital cardiac defect, annular pancreas, malrotation and genitourinary defects. [6, 7]

Intestinal obstruction from duodenal atresia can arise from internal or external factors. Internal factors include atresia, stenosis, duodenal web and intraluminal duodenal diverticulum whereas external factors are mainly compressive forces on the duodenum and include annular pancreas usually co-existing with duodenal atresia/stenosis, malrotation and occasionally preduodenal portal vein.[12]

Duodenal atresia is traditionally classified using the Grey/Skandalakis and based on location in relation to the Ampulla of Vater. [12, 13, 14]

The Grey and Skandalakis classification is as follows

Type I: Most common presentation representing over 90% of cases. It shows a normal musculature of the proximal and distal ends with an obstructing septum, web or diaphragm formed from mucosa and submucosa. In the windsock variant of this type, the septum is thin and stretches distally in the duodenum

and collapsed distal segments of the duodenum connected by a thin fibrous cord with intact mesentery.

Type III: It is seen in 7% of cases and shows a complete separation of the two segments of the duodenum. In some cases of this, multiple atresias are present.

Based on location, duodenal atresias can be either pre or post ampullary. The post-ampullary type is the most commonly encountered in practice[15].

Diagnosis of duodenal atresia could be at the prenatal or postnatal period. Polyhydramnios is often detected in more than half of the mothers and is noted as sonographic finding of double bubble or two fluid -filled cavities in the fetal abdomen.[16]

Postnatal presentation will depend on whether the intestinal obstruction is complete or incomplete.[8] In complete obstruction, the neonates will present with intractable bilious vomiting although a few will have non-bilious vomiting as seen in pre-ampullary obstructions (nearly 10% of cases). Repeated emesis, feeding intolerance, constipation and failure to thrive are also key features of duodenal stenosis, a common type of incomplete duodenal obstruction.[12] Abdominal distension is usually not common due to the proximal nature of obstruction, however gastric fullness may be appreciated clinically on examination.

A plain abdominal radiograph with the classical “double bubble “sign is diagnostic of duodenal atresia and usually enough to make clinical diagnosis[17, 18, 19,20].

Treatment options available include open duodenoduodenostomy or duodenojejunostomy and the frequently employed Kimura’s diamond shaped duodenoduodenostomy technique, Zuccarello’s inverted diamond shaped duodenoduodenostomy and laparoscopic repair. [21,22] Duodudenotomy with excision of webs is employed in cases of duodenal webs as seen in a sub-group of type 1 duodenal atresia [23] Post-operative complications have been recorded to be reduced in neonates who have prenatal diagnosis compared to the those with delayed diagnosis .[24]

This study aimed to describe the clinical profile and surgical outcomes of neonates with duodenal atresia in a Nigerian tertiary hospital and to identify factors affecting outcomes.

Material and methods

This is a 10 -year retrospective review of all consecutive neonates managed for duodenal atresia at the Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra state, Nigeria. Data were retrieved from the case notes of these patients between the periods of June 2014 to May 2025 in the Pediatric Surgery Unit of the Department of Surgery of Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria. NAUTH Nnewi is one of the three tertiary and referral hospitals in the state serving many patients from the state and neighbouring states in the South eastern Nigeria. It has four Paediatric Surgeons in its employ.

Three babies whose medical records were missing in part were excluded from this study. All newborns were admitted through the Special Care Baby Unit and managed at the Pediatric surgical ward post-operatively. There is no Neonatal Intensive Care Unit in the hospital. Initial diagnosis was largely clinical and was confirmed by plain abdominal radiographs with demonstration of double or single bubble signs. Fig 1

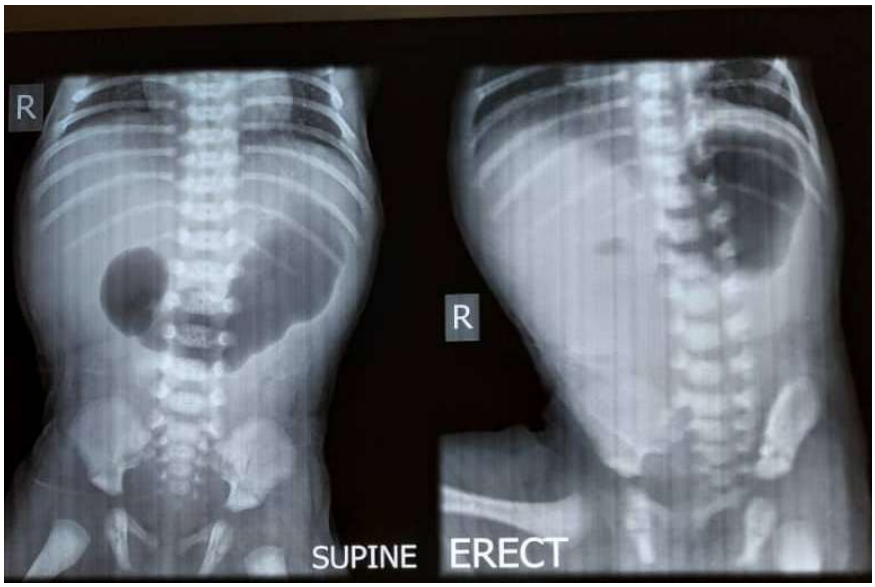

FIGURE 1: PLAIN ABDOMINAL RADIOGRAPHS SHOWING DOUBLE BUBBLE SIGNS

The babies were placed on nil by mouth and nasogastric tube passed to decompress the stomach. Fluid correction and maintenance was through the use of intravenous fluids. Electrolyte corrections were done for those with derangements. Warmth was provided with radiant warmers and incubators for the preterm babies. The babies were adequately optimized for surgery and operated in the theatre by the consultant surgeons assisted by trainee Resident doctors in the units.

Anaesthesia management required a careful perioperative assessment in view of some physiological challenges that could complicates smooth conduct of anaesthesia including aspiration, fluids and electrolyte abnormalities. General anesthesia with rapid sequence tracheal intubation is the technique of choice to minimize risk of aspiration pneumonitis. The induction of anaesthesia was achieved with 2mg/kg of ketamine followed by 1.5mg/kg of suxamethonium to facilitate endotracheal intubation. Anaesthesia was maintained with volatile agent such as isoflurane at 2-3% in 3-4 litres/ minutes of oxygen throughout the procedure. Intermittent doses of neuromuscular blocking agent i.e 0.5mg/mg of atracurium was used. Pentazocine at a dose of 0.05mg/kg and Paracetamol at 15mg/kg were subsequently administered. The abdominal incision site was infiltrated with lidocaine for local anesthesia and to provide a long acting analgesic effect after

surgery. Repairs were done using Kimura's Diamond –shaped duodenoduodenostomy (fig 2)

At the end of surgery, volatile anaesthetic gas was turned off while residual muscle relaxant was reversed with 0.04mg/kg of neostigmine and 0.08mg/kg of glycopyrrolate. Following full recovery from anaesthesia, the patient was extubated and transferred to the recovery room on supplemental oxygen until discharged to the ward to continue post-operative care with intravenous fluids, antibiotics using third generation cephalosporins and analgesia.

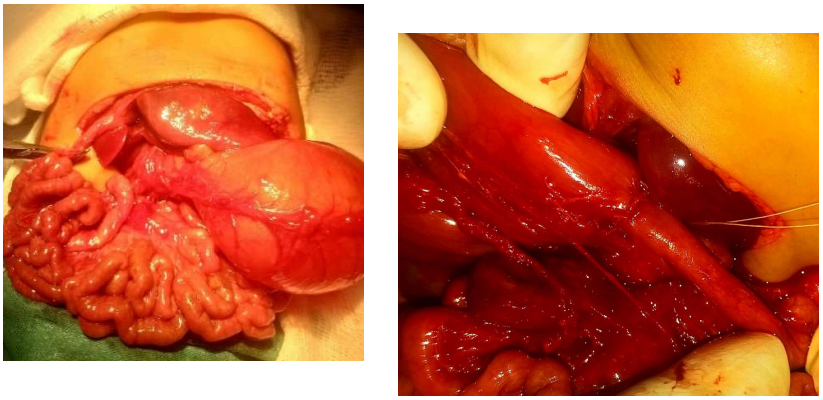

FIGURE 2: A- TYPE 3 DUODENAL ATRESIA WITH BLIND ENDING DUODENUM SEPARATED FROM THE BLIND ENDING DISTAL SEGMENT WITH A MESENTERIC GAP B- COMPLETED DIAMOND SHAPED DUODENODUODENOSTOMY

IBM Statistical Package for Social Sciences (SPSS) version 27.0 (IBM Corporation Armonk ,NY was used for data entry and analysis. Results were expressed as means, ranges and percentages and with tables. Relationships between categorical variables were performed with Chi square and Fishers exact test. A test of significance with P-value ≤ 0.05 was considered significant.

Observations

Of the 27 neonates, 17 (63.0%) were males with a male to female ratio of 1.7:1, 4 (14.8%) were delivered pre-term and 22 (81.5%) were delivered at term; 4 (14.8%) presented within first twenty-four hours of life, 17 (63.0%) presented between day one and one week of life and 6 (22.2%) presented after one week of life and the mean (± standard deviation)and median age of presentation was 6.33 (± 5.824) days and 4 days respectively;

13 (48.1%) were underweight at birth and other 14 (51.9%) were within normal weight with mean birth weight of 2.491 ± 0.6616 kg; 19 (70.4%) of the neonates were delivered at a private specialist canters, and 5 (18.5%) were delivered at a tertiary hospital, while others were delivered either in a general hospital, maternity clinic or at home. (Table 1)

TABLE 1: SOCIODEMOGRAPHIC CHARACTERISTICS OF STUDY POPULATION

Variables	Frequency (n=27)	Percent
Sex		
Male	17	63.0
Female	10	37.0
Gestational Age (at delivery)		
Pre-term	4	14.8
Term	22	81.5
Post-term	1	3.7
Age at time of presentation		
Within first 24 hours	4	14.8
24 hours to 1 week	17	63.0
7 days to 21 days	6	22.2
Mean age ± SD (in days)	**6.33 ± 5.824**	
Median age ± SD (in days)	**4.00 ± 5.824**	
Birth Weight		
Underweight (≤ 2.5kg)	13	48.1
Normal Weight (2.5kg – < 4.0kg)	14	51.9
Overweight (≥ 4.0kg)	0	0
Mean birth weight ± SD (in kg)	**2.491 ± 0.6616**	
Birth Facility		
Home	1	3.7
Private Specialist Center	19	70.4
General Hospital	1	3.7
Tertiary Hospital	5	18.5
Maternity Clinic	1	3.7

Of the 27 babies, only 2 (7.4%) had prenatal diagnosis of duodenal atresia; 7 (25.9%) had prenatal ultrasound scan diagnosis of polyhydramnious in utero; 20 (74.1%) presented with bilious vomiting, 4 (14.8%) had non-bilious vomiting, 10 (37.0%) had fever at presentation, 8 (29.6%) were jaundiced, 6 (22.2%) were breathless, 5 (18.5%) had upper abdominal distension and 4 (14.8%) had presenting complaint of convulsion prior to presentation. Table 2

TABLE 2: PATTERN OF PRESENTATION OF DUODENAL ATRESIA

Variables	Frequency (n=27)	Percent
Had prenatal diagnosis of Duodenal atresia		
Yes	2	7.4
No	25	92.6
Pregnancy complicated by polyhydramnios		
Yes	7	25.9
No	20	74.1
Presenting Complains*		
Bilious vomiting	20	74.1
Non-bilious vomiting	4	14.8
Fever	10	37.0
Jaundice	8	29.6
Upper abdominal distension	5	18.5
Breathlessness	6	22.2
Convulsion	4	14.8
Others**	3	11.1
Not known	2	7.4

*Multiple response questions

**Excessive crying, Irritability

Other associated congenital anomalies were seen in 4 (14.8%) and included malrotation syndrome (most common), spinal bifida, TAR and

VACTERL; 17 (63.0%) had at least one electrolyte deranged including sodium (70.6%), chloride (52.9%), urea (47.0%), Creatinine (41.2%), Potassium (35.3%) and Bicarbonate (17.6%); 14 (51.9%) of the 27 neonates had type 1 duodenal atresia, 4 (14.8%) had type 2 duodenal atresia and 9 (33.3%) had type 3 duodenal atresia according to Greys and Skandalaski's Classification; 3 (11.1%) had pre-ampullary and others (88.9%) had post-ampullary atresia. See table 3

TABLE 3: ANOMALIES ASSOCIATED WITH DUODENAL ATRESIA ELECTROLYTE STATUS AND TYPES

Variables	Frequency (n=27)	Percent (%)
Presence of associated congenital anomalies		
Yes	6	22.2
No	21	77.8
Other congenital anomalies	**(n = 6)**	
Malrotation syndrome	3	50.0
Spinal bifida	1	16.7
TAR + ? TOF*	1	16.7
VACTERL**	1	16.7
Presence of Electrolyte Derangements		
Yes	17	63.0
No	10	37.0
Deranged Electrolytes* **	**(n = 17)**	
Sodium	12	70.6
Potassium	6	35.3
Bicarbonate	3	17.6
Chloride	9	52.9
Urea	8	47.0
Creatinine	7	41.2
Greys and Skandalaski's Classification of Duodenal Atresia		
Type 1	14	51.9
Type 2	4	14.8
Type 3	9	33.3

Type of Duodenal Atresia Based on Location		
Pre-ampullary	3	11.1
Post-ampullary	24	88.9

*Thrombocytopenia-Absent Radius Syndrome with ? Tracheoesophageal Fistula

**Vertebral defects, anorectal malformation, cardiac defects, tracheoesophageal fistula, renal abnormalities and limb defects.

***Multiple response questions

Twenty-three (85.2%) of the 27 neonates had Kimura's duodenoduodenostomy, 3 (11.1%) had Ladd's procedure in addition to Kimura's duodenoduodenostomy and 1 (3.7%) had duodenal web excision; 12 (44.4%) had surgery within 48 hours on presentation, 14 (51.9%) had surgery between 48 hours and 1 week; 16 (59.3%). All surgeries were performed with general anaesthesia with endotracheal intubation with infiltration of the incision site with lignocaine ; 15 (55.6%) of the 27 neonates recommenced oral intake between 3 days and 1 week after surgery, 5 (18.5%) recommenced oral intake after one week. Table 4

TABLE 4: TREATMENT OPTIONS OF DUODENAL ATRESIA AND POST-OPERATIVE MANAGEMENT

Variables	Frequency (n=27)	Percent
Surgical Procedure Done		
Kimura's Duodenoduodenostomy	23	85.2
Kimura's Duodenoduodenostomy + Ladd's Procedure	3	11.1
Duodenal Web Excision	1	3.7
Duration between presentation and surgery		
Within 48 hours	12	44.4
Between 48 hours and 1 week	14	51.9
After 1 week	1	3.7
Post-Operative Day Neonate recommenced Oral intake		
Never	7	25.9
Between 3 days to 1 week	15	55.6

After 1 week	5	18.5

The complication profile is as in table 5 with post-operative vomiting as the most common event after surgery followed by respiratory distress ;17 (63.0%) of the 27 neonates got discharged post operatively, of which 2 (11.8%) were after one week, 10 (58.8%) were after two weeks and 5 (29.4%) were after three weeks; of the 10 neonates that died on admission, 2 (20.0%) died less than a week post-surgery, 7 (70.0%) died between one and two weeks, and 1 (10.0%) died after two weeks post-surgery; the mean duration on admission of all the neonates, irrespective of outcome, was 16.85 ±11.265 days and 30-day post-operation outcome had 17 (63.0%) alive and 10 (37.0%) dead.

TABLE 5: POST-OPERATIVE COMPLICATIONS AND OUTCOME FOR DUODENAL ATRESIA MANAGEMENT

Variables	Frequency (n=27)	Percent
Post-Operative Complications*		
Non-bilious Vomiting	10	37.0
Respiratory distress	7	25.9
Jaundice	6	22.2
Anaemia	5	18.5
Seizure	3	11.1
Sepsis	3	11.1
Surgical Site Infection	3	11.1
Pulmonary Oedema	2	7.4
Bilious Vomiting	1	3.7
Fever	1	3.7
Acute Kidney Injury	1	3.7
Hyperkalemia	1	3.7
Reactionary Hemorrhage	1	3.7
Cardiac Failure	1	3.7
Burst Abdomen	1	3.7
Admission Outcomes		
Discharged	17	63.0
Demise on admission	10	37.0
If discharged; day of discharge	**(n = 17)**	
Less than one week	0	0

One week to two weeks	2	11.8
Two weeks to three weeks	10	58.8
Over three weeks	5	29.4
If died on admission; day of death	**(n = 10)**	
Less than one week	2	20.0
One week to two weeks	7	70.0
Two week to three weeks	1	10.0
Mean duration of admission ± SD (in days)	**16.85 ± 11.265**	
30 Days Post-Operative Outcome	**(n = 27)**	
Alive	17	63.0
Dead	10	37.0

*Multiple response question

Of the 10 neonates that died post-operatively, 6 (60.0%) had lower respiratory tract infection, 5 (50.0%) had intractable non-bilious vomiting, 3 (30.0%) had sepsis, 1 (10.0%) had cardiac failure, 1 (10.0%) had acute kidney injury and 1 (10.0%) neonate had hyperkalemia

TABLE 6: POSSIBLE CAUSES OF DEATH IN NEONATES WITH POST-OPERATIVE DEMISE

Variables	Frequency (n=10)	Percent
Cause of Death*		
Lower respiratory tract infection	6	60.0
Intractable non-bilious vomiting	5	50.0
Sepsis	3	30.0
Cardiac failure	1	10.0
Acute Kidney Injury	1	10.0
Hyperkalemia	1	10.0

*Multiple response questions

The relationship between the gestational age of delivery and post-operative outcome of neonates who had surgery for duodenal atresia was statistically significant and showed that all pre-terms had post-operative

demise while majority of term (and post-term) neonates had a good outcome. The relationship between the sex of the neonate, age at the time of presentation, birth weight birth facility and their post-operative outcome were not statistically significant. Table 7

TABLE 7: RELATIONSHIP BETWEEN SOCIODEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION AND THE POST OPERATIVE OUTCOME

Variables	Post-Operative Outcome		Test Statistics (χ^2)	p-value
	Discharged (n = 17) Freq (%)	Demised (n = 10) Freq (%)		
Sex				
Male	12 (70.6)	5 (29.4)	1.144	0.285
Female	5 (50.0)	5 (50.0)		
Gestational Age (at delivery)				
Pre-term	0 (0)	4 (100)	8.288	0.016*
Term	16 (72.7)	6 (27.3)		
Post-term	1 (100)	0 (0)		
Age at time of presentation				
Within first 24 hours	1 (25.0)	3 (75.0)	3.562	0.168
24 hours to 1 week	11 (64.7)	6 (35.3)		
7 days to 21 days	5 (83.3)	1 (16.7)		
Birth Weight				
Underweight (≤ 2.5kg)	7 (53.8)	6 (46.2)	0.894	0.345
Normal Weight (2.5kg – < 4.0kg)	10 (71.4)	4 (28.6)		
Overweight (≥ 4.0kg)	0 (0)	0 (0)		
Birth Facility				
Home	0 (0)	1 (100)	8.041	0.090
Private Specialist Center	12 (63.2)	7 (36.8)		
General Hospital	0 (0)	1 (100)		
Tertiary Hospital	5 (100)	0 (0)		
Maternity Clinic	0 (0)	1 (100)		

***Statistically significant**

Seventy five percent of the babies who had associated congenital anomalies had poor post-operative outcome while 69.6% of the neonates who did not have congenital anomalies had good post-operative outcome. This relationship was however not statistically significant (at p = 0.088). The relationships between the presence of electrolyte derangements, the types of duodenal atresia and the post-operative outcome were also not statistically significant. Table 8

TABLE 8: RELATIONSHIP BETWEEN PRESENCE OF COMORBIDITIES, TYPE OF DUODENAL ATRESIA AND THE POST-OPERATIVE OUTCOME

Variables	Post-Operative Outcome			
	Discharged (n = 17) Freq (%)	Demised (n = 10) Freq (%)	Test Statistics (χ^2)	p-value
Presence of associated congenital anomalies				
Yes	1 (25.0)	3 (75.0)	2.902	0.088
No	16 (69.6)	7 (30.4)		
Presence of Electrolyte Derangements				
Yes	5 (50.0)	5 (50.0)	1.144	0.285
No	12 (70.6)	5 (29.4)		
Greys and Skandalaski's Classification of Duodenal Atresia				
Type 1	10 (71.4)	4 (28.6)	2.002	0.367
Type 2	3 (75.0)	1 (25.0)		
Type 3	4 (44.4)	5 (55.6)		
Type of Duodenal Atresia Based on Location				
Pre-ampullary	1 (33.3)	2 (66.7)	1.271	0.260
Post-ampullary	16 (66.7)	8 (33.3)		

Discussion

Among the 27 neonates reviewed, 17 of them representing 63% of the total population were males while 10 (37%) were females. This finding is consistent with previous

studies on duodenal atresias in which more than half of the children were males. The reason for this male preponderance in children with duodenal atresia has remained unclear.[7,10, 24] Majority of the newborns were born at term whereas only 14.8% were preterm at birth. This find is also similar to studies in other countries .[24,25] Higher rate of preterm delivery among babies with duodenal atresia may not be unconnected with polyhydramnious which is a risk factor for preterm births.

Most of the neonates presented after 24 hours to 7 days of life and the mean age at presentation was 6 days. This delayed presentation is in contrast to patterns in developed countries where the children presented within the first 24 hours and surgical interventions were done within 2 days of life. [7, 24] This trend not only could delay the needed urgent surgical intervention but can also affect the overall outcome post-operatively. This could be attributed to the fact that majority of the neonates were born outside the teaching hospital or specialist centres and subsequently transferred from other facilities. Majority of the children were of normal birth weight with only a few underweight and very low birth weight babies. This is consistent with findings with some studies in Nigeria where most of the newborn were of normal birth weight.[1, 7]

Of the 27 newborns, only 2 representing 7.4% of the total had prenatal diagnosis as majority were diagnosed post-natally. This is in keeping with a study done in Lagos, Nigeria where diagnosis of duodenal atresia was either from radiological investigations after birth or at surgery.[29] The reason for this observation could be due to less than optimal health seeking behavior and antenatal care of mothers in our subregion[26]. Another plausible reason could also be the fact that a significant number of women still use maternal homes and traditional birth centers for antenatal services in developing countries thereby causing missed opportunities for ultrasound suspicion of gut anomalies at specialized hospitals.[27]

The most common presentation was bilious vomiting, others were; non-bilious vomiting, fever, jaundice, breathlessness and upper abdominal distension in descending order. This pattern of presentation is classical of intestinal obstruction secondary to duodenal atresia/stenosis and is consistent with findings in Lagos, India and the United Kingdom. A rarer presenting symptom identified was convulsion and this could be reasonably explained as a complication of electrolyte imbalance particularly among the late presenting patients.[24,28,29,30]

More than half of the study population had type I duodenal atresia and majority of the identified intestinal obstruction was post ampullary. This is a similar outcome when compared to previous studies on duodenal atresia where both type 1 and post ampullary atresia where the most common types.[24]

Only a few of the patients representing about 22.2% had associated congenital anomalies in sharp contrast to a study in Poland where more than 68% of the children with duodenal atresia were found to have co-existing problems.[25] The reason for this discrepancy could be the retrospective nature of this study and unavailability of some screening facilities such as echocardiography to pick up congenital cardiac anomalies beyond what clinical assessment could offer. The most commonly identified anomalies in the newborns with duodenal atresia were midgut malrotation, others were spinal bifida, Thrombocytopenia-Absent radius syndrome with tracheosophageal fistula and VACTERL, a similar finding with other studies.[28] This underscores the need for efforts to look out for associated anomalies in duodenal atresias.

Majority of the neonates had electrolyte derangements and hyponatremia was the most common. This could be alluded to the fact that presentation to the hospital was delayed in majority of them and also due to dehydration and fluid loss from vomiting and fever.[16]

Surgical repair was delayed in most of the newborns with only 44% operated within 48 hours of presentation to the hospital. This could be both due to late presentation from referral centers and the need for resuscitation and optimization for surgery. Again, financial constraints arising from the cost of surgery as healthcare expenditure is largely out of pocket in Nigeria as also a source of delay.

Kimura's diamond shaped- duodenoduodenostomy was the most utilized technique of repair with web excision only performed in one patient. This is despite the fact that majority presented with type 1 atresias which could be amenable to web excisions however the proximities of the obstructions to the ampulla of Vater informed the Diamond shaped duodenoduodenostomy as a safer option. None of the babies had laparoscopic repair, this is because of the technicalities involved and the challenge of anesthesia which are yet to be developed to in our centre in the stated study period.[21,22,23] All surgeries were performed under general anaesthesia with endotracheal intubation however, those that needed ventilatory support could not get that service as we did not have a neonatal intensive care unit within the period of this study.

Postoperative vomiting was the most common post-operative complication and was followed by respiratory distress, jaundice, anemia, seizure, sepsis and surgical site infection. Other complications following surgery were pulmonary edema, fever, acute kidney injury, hyperkalemia, reactionary hemorrhage, cardiac failure and burst abdomen. The post-operative vomiting were managed conservatively with reinsertion of the nasogastric tubes and resolved over time while those with respiratory distress secondary to aspiration were also managed with suctioning, oxygen therapy,

antibiotics and steroids. Anaemia was corrected with transfusions and surgical site infections treated with dressings and antibiotics. This finding mirrors a previous study where post-operative complications where characterized as mild including occasional constipation, abdominal distension and vomiting.[25]

The mean duration of admission was approximately 17 days irrespective of the final outcome of surgical management with a range of 11 to 17 days. This duration of hospital stay is consistent with other studies where the neonates stayed for an average of 14 days. [24] Mortality was high at 37% as only 17 of the admitted patients were discharged home after surgery. The most implicated cause of death was lower respiratory tract infection, intractable bilious vomiting and sepsis. All the discharged patients were seen at 30 days follow-up with no new complaints. The high mortality rate could be due to the delayed diagnosis and presentation and is similar to a study in the Southwestern region of the country and in contrast to a study in a developed country where mortality rate was 3%. The lower mortality rates in the developed countries are largely because of the availability of parenteral nutrition and neonatal intensive care units with specialist pediatric intensivists and nurses [24,29]

Among the newborns who died while being managed post-operatively, mortality was 100% for the preterm babies and this was found to be statistically significant. These deaths could be due to the many problems associated with prematurity including hypothermia, respiratory distress and apnoea, hypoglycemia, sepsis and decreased/poor immune response to trauma and stress of surgery. A similar outcome was also seen in a study in India where over half of the preterm babies with duodenal atresia died while convalescing from surgical repair.[30]

Although the majority of deaths came from cases that presented from private hospitals, it was found not to be statistically significant. In this same pattern, mortality rate was high among those with associated congenital anomalies and electrolyte derangements, however both had no significant link with the overall surgical outcome and survival. Sex of the newborn, age at presentation, birth weight and type of duodenal atresia also had no significant association with post-operative outcome.

Conclusion

Duodenal atresia is a common cause of bowel obstruction in the newborn. Despite improved outcome due to prenatal diagnosis, availability of specialized paediatric intensive care units and parenteral nutrition in North America and Europe, surgical outcome is still poor in developing countries as patients present late in compromised

states and diagnosis is mostly made after birth with the aid of plain abdominal radiographs. Mortality in the index study was high at 37% and prematurity was the major factor significantly associated with mortality.

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