International Surgery Journal
Agade IW et al. Int Surg J. 2024 Oct;11(10):1590-1597
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20242757

Original Research Article

Early surgical outcomes of children with mechanical intestinal obstruction at Moi teaching and referral hospital, Kenya

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Received: 16 July 2024
Revised: 20 August 2024
Accepted: 02 September 2024

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ABSTRACT

Background: Intestinal obstruction constitutes the largest proportion of abdominal surgical emergencies in the paediatric and adult patients in Sub-Saharan Africa, including Kenya. It is associated with high postoperative surgical complication and mortality rate in low resource healthcare systems.
Methods: A prospective mixed methods study with consecutive sampling procedure was carried out from September 2021 to June 2023. Pediatric patients from birth to 14 years, with mechanical intestinal obstruction were included in the study. Categorical data was analyzed in frequencies and percentages and continuous data was analyzed using measures of central tendency and measures of dispersion. Bivariate and multivariate associations between the dependent and independent variables were assessed with a p value of less than 0.05 being statistically significant.
Results: The final study population was 318 participants. Majority of participants were male with neonates comprising almost one third of participants. Classical symptoms were present in a majority of patients at initial presentation. Intussusception (34.6%) was the leading acquired aetiology of paediatric mechanical intestinal obstruction. Operative surgical management was in 94.6% of participants. Surgical complications were present in 61.1% of participants. The commonest surgical complication was surgical site infection in 16.9%. Overall mortality rate was 10.2% with 23.3% among neonates and 4.9% in older children. Referral status was statistically associated with mortality ($p<0.001$). Intestinal atresia had the highest case-specific mortality rate. Age, presence of comorbidity were factors associated to postoperative complications and mortality ($p<0.05$).
Conclusions: The overall mortality rate was 10.2%. A higher mortality was seen among neonates compared to older children.

Keywords: Classical symptoms, Non-classical symptoms, Early surgical outcomes

INTRODUCTION

Intestinal obstruction occurs when there is a disruption in the normal transit of intestinal contents caused by either mechanical or functional causes. Worldwide, intestinal obstruction constitutes the largest proportion of abdominal surgical emergencies in both the pediatric and the adult patient.[1-3] Mechanical bowel obstruction is the most common cause of abdominal surgical emergencies among pediatric patients in Sub-Sahara Africa including Kenya.[4-7] In Kenya, this has been the trend reported among pediatric patients with an acute abdomen since the 1980's.[8] There are several etiologies of mechanical intestinal obstruction in pediatric patients that vary in different age groups, at different time periods and within different populations.[3,8]

There are four cardinal signs in the presentation of intestinal obstruction; Classical symptoms such as vomiting, abdominal distension, constipation and

abdominal pain are common at initial patient presentation. Abdominal distension has been reported as an alarming sign to healthcare workers who are subsequently more likely to refer a pediatric patient to a pediatric surgeon in its presence.[20] The variability and timing in presentation of these symptoms is normally predetermined by the duration, type and site of obstruction. A diagnosis of intestinal obstruction is often missed when patients do not present with the classic symptoms.[11] In the tropics, pediatric patients with intestinal obstruction from intussusception have reportedly been managed for gastroenteritis and invariably for rectal prolapse in the case of trans anal protrusion of the intussusception (TAPI).[9] This delay in the diagnosis equating to delay in the initiation of standard treatment further increases surgical complications and mortality associated with mechanical intestinal obstruction in the surgical pediatric patient.

Management of childhood mechanical intestinal obstruction in low resource health care systems is greatly hampered by lack of resources. In Ghana, accessibility, availability and affordability of surgical services characterized by an inverse distribution of healthcare facilities in relation to population needs.[10] In Malawi, lack of pediatric surgeons coupled with the decreased comfort level of the available general surgeons in treating pediatric surgical cases, more so in handling of neonatal surgical emergencies, leads to fewer patients receiving necessary surgical care.[3]

In LMIC characterized by low resource healthcare systems, surgical complication rate associated with pediatric intestinal obstruction patient is high at 33% and 22% in Niger and India respectively.[8,11] Mortality rate associated with pediatric intestinal obstruction is below 1% in the developed countries despite the studies from developed countries having larger study populations.[12] A mortality rate of 5% among pediatric patients, excluding neonatal patients, with mechanical intestinal obstruction was reported in a retrospective review in Tenwek hospital, Western Kenya.[18] In MTRH, mortality associated with neonatal and pediatric intestinal obstruction, both mechanical and functional, is 18.8% and 16.8% as reported in 2015 and in 2019 respectively.[17-19]

The intent of this study was to assess early surgical outcomes in pediatric patients with mechanical intestinal obstruction at MTRH. Highlighting these outcomes and associated factors, more so the amenable factors, will be of value in decreasing perioperative surgical complications and mortality associated with mechanical intestinal obstruction in childhood in a low resource healthcare system such as Kenya.

METHODS

This study was conducted between September of 2021 and June 2023 at Moi teaching and referral hospital, one of two level six healthcare facilities in Kenya. It is also the only hospital equipped to offer paediatric surgical services in Western Kenya. It was a prospective observational study. Approval was sought and granted from the institutional review and ethics board (approval number 003974) and the national commission for science, technology and innovation (NACOSTI) (Research license number 89670). All paediatric patients from birth up to fourteen years of age, with a diagnosis of mechanical intestinal obstruction were included in the study. Patients who were referred with a persistent intestinal obstruction following initial operative management at another facility within 30 days of referral were excluded from the study. Fischer's formula was used to calculate the sample size of 318 participants. Patients were enrolled into the study at initial admission and were followed up until discharge by the surgical team. A structured data collection form was used encompassing both interviews and participant's chart reviews. Data collected included independent variables such as demographic factors including age and sex, residence and the dependent variables as early surgical outcomes of interest, surgical complications, length of stay and mortality. Data was analysed by STATA version 16. Continuous data was analysed using measures of central tendency and measures of dispersion. Categorical data was expressed in percentages and frequencies. Chi-square test was used for associations between two categorical variables with a p value of less than 0.05 was considered statistically significant. Categorical data will be presented in frequency tables. Both data types will also be presented in prose.

RESULTS

These findings are based on 318 patients aged 1 day to 168 months (14 years) old with a diagnosis of mechanical intestinal obstruction. Males constituted majority of the study participants representing 59.1% (n=188) with females representing the minority at 40.9% (n=130). Neonates constituted almost one third of the study participants. Participants' demographics were as shown in Table 1.

Table 1: Demographic characteristics of study participants, (n=318).

Characteristics	N	Percentage (%)
Sex		
Male	188	59.1
Female	130	40.9
Age group (in years)		
0-28 days	91	28.6
1-12 months	100	31.5
1-5	83	26.1
5-14	44	13.8

Only 26.7% (n=85) were admitted from home, while 73.2% (n=233) were formally referred from other health care providing facilities. At the referring facility a diagnosis of intestinal obstruction was made in 77.3%

(n=180) of the formally referred patients. Among the referred patients, 22.7% (n=53) had a diagnosis other than intestinal obstruction on referral such as malaria, meningitis, amoebiasis or gastroenteritis. Classical intestinal obstruction symptoms such as vomiting and abdominal distension were present in majority of the participants. Non-classical symptoms were present in some participants as summarized in Figure 1.

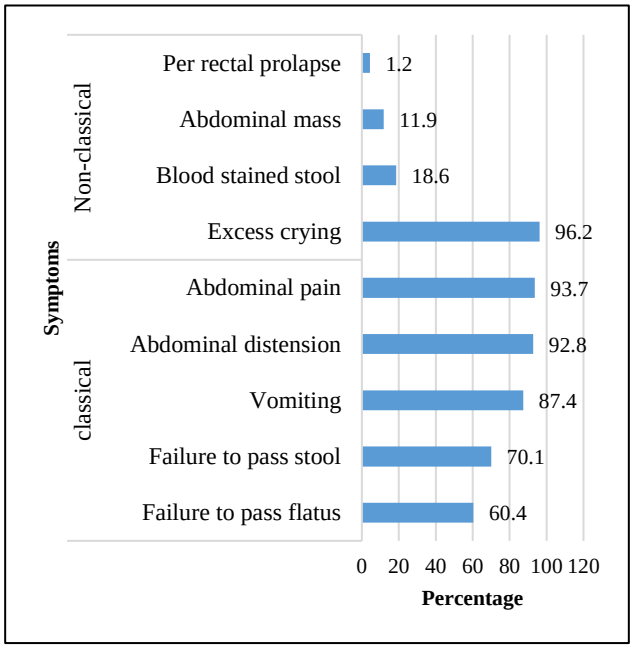

Figure 1: Study participants' presenting symptoms at initial presentation.

As shown in Table 2, majority 64.2% (n=208) had an acquired etiology of mechanical intestinal obstruction while 35.8% (n=116) had mechanical intestinal obstruction secondary to a congenital pathology. Intussusception, postoperative adhesive bowel disease, inguinal hernia and umbilical hernia were the most prevalent acquired intestinal obstruction diagnoses in 38.9% (n=72), 21.6% (n=40), 15.1% (n=28) and 15.1% (n=28) of study participants, respectively.

Intraluminal helminthic, intra-abdominal tumors were among the least diagnosed etiology occurring in 2.1% (n=4) and 0.5% (n=1) of the study participants respectively.

Ano-rectal malformation was the most prevalent among congenital diagnosis accounting for 57.8% (n=67) of the total congenital mechanical intestinal obstruction cases.

Operative surgical management was offered in 94.6% (n=301) of study participants while only 5.4% (n=17) patients underwent non-operative surgical management of mechanical intestinal obstruction. 45.6% (n=145) of participants had gangrenous bowel necessitating bowel resection followed by either primary bowel anastomosis or stoma fashioning.

Postoperative complications were recorded in 61.3% (n=204) of participants which included, length of stay >7 days, enterocutaneous fistula and anastomotic leaks occurring in the course of management.

Surgical site infection was the most common perioperative surgical complication encountered among study participants.

Table 2: Study Participants definitive diagnosis.

Characteristics	N	Percentage (%)
Acquired diagnosis	n=185	
Intussusception	72	38.9
Adhesion postoperative	40	21.6
Inguinal hernia	28	15.1
Umbilical hernia	28	15.1
Adhesions post inflammatory	10	5.4
Intraluminal helminths	4	2.1
Post traumatic Adhesions	3	1.6
Intra-abdominal tumours	1	0.5
Congenital diagnosis	n=133	100
Ano-rectal malformation	67	50.3
Intestinal atresia	48	36.2
Volvulus (With associated malrotation)	18	13.5

Table 3: Participants' post-operative complications.

Post-operative complication	N	Percentage (%)
Anastomotic leak	n=318	100
	Yes-2	2.8
	No-316	97.2
Surgical site infection	n=318	100
	Yes-51	16.0
	No-267	84.0
Enterocutaneous fistula	n=318	100
	0	0
Length of stay >7 days	n=318	100
	Yes-195	61.3
	No-123	38.7

Overall mortality was 10.2% (n=33). Mortality rate was 23.1% (n=23) among neonates compared to mortality rate 4.9% (n=11) among 1 month to 14 year old patients.

Tables 4 and 5 illustrate the various demographic and clinical factors associated with mortality at the bivariate and multivariate level.

The highest case specific mortality rate occurred among those with intestinal atresia at 22.9% (n=11) and volvulus with associated malrotation at 22.2% (n=18), followed by ano-rectal malformation 13.4% (n=9) and inguinal hernia at 10.7% (n=3) as summarized in Table 7.

Table 4: Bivariate associations between participants demographic and clinical characteristics association with in-hospital mortality.

Characteristics	In hospital mortality		P value
	Absent, N (%)	Present, N (%)	
Age	286 (89.9)	32 (10.1)	
0-28 days	70 (76.9)	23 (17.2)	<0.001[c]
1 month-14 years	216 (95.1)	9 (4.8)	
Referral	286 (89.9)	32 (10.1)	
No	85 (100)	0	<0.001[c]
Yes	201 (86.3)	32 (13.7)	
Duration of surgery (hours)	286 (89.9)	32(10.1)	
<3	129 (90.2)	14 (9.8)	0.820[c]
≥3	92 (89.3)	11 (10.7)	
Aetiology of bowel obstruction	286 (89.9)	32 (10.1)	
Acquired	190 (94.1)	12 (5.9)	0.001[c]
Congenital	96 (82.8)	20 (17.2)	
Morbidity	286 (89.9)	32 (10.1)	
Absent	81 (95.3)	4 (4.7)	0.055[c]
Present	205 (88)	28 (12)	
Gender	286 (89.9)	32 (10.1)	
Male	163 (86.7)	25 (13.3)	0.021[c]
Female	123 (94.6)	7 (5.4)	
White blood cell count	286	32 (10.1)	
Normal (4-11)	181 (92.3)	15 (7.7)	0.036[c]
Abnormal (Below 4 and above 11)	88 (84.6)	16 (15.4)	
Comorbidity	286 (89.9)	32 (10.1)	
Absent	203 (92.3)	17 (7.7)	0.038[c]
Present	83 (84.7)	15 (15.3)	
Length of stay (in days)	286 (89.9)	32 (10.1)	
Below 7	104 (84.5)	19 (15.5)	0.011[c]
Above 7	182 (93.3)	13 (6.7)	

[c]Chi square test.

Table 5: Multivariate analysis between participants demographic and clinical characteristics association with in-hospital mortality.

Characteristics	aOR	95% CI	P value
Age (in months)			
0-28 days	4.97	1.43-17.25	0.011
1-168	1		
Etiology of bowel obstruction			
Acquired	1	0.48-5.57	0.426
Congenital	1.64		
Surgical complications			
Absent	1	2.75-43.41	0.001
Present	10.93		
Gender			
Male	2.78	0.99-7.78	0.052
Female	1		
Comorbidity			
Absent	1	0.43-3.00	0.806
Present	1.13		
LOS in days			
Below 7	12.73	4.45-36.39	<0.001
Above 7	1		

Table 6: Case specific mortality rates as per etiology of childhood mechanical intestinal obstruction.

Etiology	N	Mortality	
		No (%)	Yes (%)
Acquired etiologies	185	176	9 (4.9)
Intussusception	72	68 (94.4)	4 (5.6)
Adhesion postoperative	40	40 (100)	1 (8.3)
Inguinal hernia	28	25 (89.3)	3 (10.7)
Umbilical hernia	28	28 (100)	0
Post inflammatory	10	9 (90)	1 (8.3)
Intra-abdominal tumors	4	4 (100)	0
Intraluminal helminths	4	4 (100)	0
Post traumatic	3	3 (100)	0
Congenital etiologies	133	110	23 (17.2)
Ano-rectal malformation	67	58 (86.6)	9 (13.4)
Intestinal atresia	48	37 (77.1)	11 (22.9)
Volvulus (With associated malrotation)	18	14 (77.8)	3 (22.2)

DISCUSSION

Majority of the study population, 71.4% were in between one month to fourteen years of age. Minority, at 28.6% of the study participants were in the neonatal age group. This is similar to findings from a teaching hospital in Niger, where 76.9% aged between one month and fifteen years versus 19.2% being neonates.[8] The slightly higher percentage of neonatal patients in this study could be due to MTRH being the only center in Western Kenya that offers newborn surgical care subsequently having a high influx of neonatal surgical referrals.

The overall median age at presentation was 7 months. The median age at presentation among neonates was 3 days. The median age at presentation among the one month to 14 years age group was 12 months. Similarly, Adamou et al reported a median age of 12 months.[8] Intussusception as a major leading cause of mechanical bowel obstruction had had a peak incidence between 3 months to 9 months in several published papers. This study reports intussusception as the leading cause of childhood mechanical intestinal obstruction, in alignment with our median presentation age of 7 months. Ooko et al reported a mean age of presentation at 6.7 years while Shiekh et al reported 55% of their study population to be aged between 3-5 years.[13-14] The latter and former studies had fewer neonates and infants with a majority of their study participants with mechanical intestinal obstruction being in the 1 year to 5 years age bracket with an acquired etiology of mechanical bowel obstruction. This study had a third of the study participants being neonates, explaining the median age at presentation being younger than in other studies.

Several published studies report a male predominance among pediatric patients diagnosed with mechanical intestinal obstruction. This seems to cut across all age groups including adult and geriatric patients.[13] In this study, 59.1% of the participants were male. Comparably, Shah et al reported more than half of his study population being male at 57%.[3] This is due to main causes of mechanical intestinal obstruction such as inguinal hernias and anorectal malformations being more common in males compared to female surgical patients.[14,15] A close to equal distribution of a male to female ratio of 1:0.8 was reported in Pakistani study.[16] Mir and Bali reported a female predominance in their study population with a male to female ratio of 1:1.2.[17] Both studies both had helminthic intraluminal mechanical obstruction as the most common etiology which has not been shown in published literature to exhibit any gender predilection. This further supports the well documented pattern of congenital causes of mechanical intestinal obstruction in the pediatric patient being more common among males.

MTRH was established as one of two level six hospitals in Kenya. Additionally, it is the only publicly funded health care facility in western Kenya with neonatal and pediatric surgical resources, hence, a high number of pediatric referrals from neighboring healthcare providing facilities have been the norm. In this study, 74% were formally referred and accompanied while 26% were admitted directly from home. Twenty years ago, Kuremu on his study on intussusception at MTRH, had similar referral patterns with 61% of his study participants being referrals.[18]

The majority of the study participants presented with classic symptoms of intestinal obstruction such as vomiting in 87.4%, not passing stool in 70.1%, failure to pass flatus in 60.4 % and abdominal distension in 92.8%. In 2016, Ooko et al reported similar patient presentation patterns in Western Kenya comparable to several findings on mechanical intestinal obstruction in children across the globe.[5,17,19,20] Abdominal distension is reported to be a more alarming symptom and sign to healthcare workers in diagnosing intestinal obstruction[21] and a child was more likely to be referred for proper management in its presence.[18]

In consonance with multiple studies on mechanical intestinal obstruction from low resource health care systems, we report surgical site infections and sepsis as the most common markers of perioperative surgical complications.[8,11,16] Bowel perforation or gangrene necessitating bowel resection was present in 45.9%. Additionally, 15% of the study population had bowel resections as part of standard surgical care of conditions such as bowel atresia. According to centre for disease surgical wounds classification, surgical wounds encountered in this study were majorly clean contaminated, contaminated or dirty wounds associated with up to 30-40% chance of developing a surgical site infection.[22] This is comparable to a study from Tanzania, whose study population included both functional and mechanical aetiologies of childhood intestinal obstruction, which reported 53% of their surgical wound classification being clean contaminated.[23] The latter study reported comparable rates of surgical site infections.

A statistically significant association between age and mortality is noted in this study with neonates having higher odds (4.97) of mortality compared to those aged 1-168 months. A higher mortality in neonates at 23.1% was reported in this study compared to a mortality of 4.9% among 29 days to 14 year old study group. Adamou et al reported similar findings with a higher mortality rate of 33% among neonates with a 11.1% mortality rate among infants and older children.[8] In this study, 70% of the co-morbid diagnoses such as neonatal sepsis and prematurity, were diagnosed in neonates, which most likely contributed to their increased mortality rate when compared to the older children.

Referral from another healthcare facility for definitive care at MTRH exhibits a statistically significant association with mortality. All mortalities were reported among referred patients. 20.7% of referred patients had a referral diagnosis other than intestinal obstruction. Most referred patients have non-classical symptoms, which have been linked to misdiagnosis and consequently a delayed diagnosis.[9,18] Paucity of knowledge on safe neonatal referral practices has been reported among healthcare practitioners of varied cadres in health care facilities referring to MTRH.[24] Apart from further deteriorating the already decompensated physiology of the pediatric patient who has had a delayed diagnosis while on management for other ailments, non-adherence to safe transport principles add other disease processes such as aspiration pneumonia in a neonate with intestinal obstruction transported without a nasogastric tube; further worsening eventual management outcome.

With regard to the aetiology of mechanical intestinal obstruction, intestinal atresia had the highest case-specific mortality rate at 22.9% with intussusception being second accounting for 5.6% of mortalities. In 2015 at MTRH, a 40% case specific mortality was associated with intestinal atresia.[13] A South African Study on intestinal atresia reports a lower mortality rate of 19.6%.[25] The latter study reports adequate supply and adequate use of total parenteral nutrition for intestinal atresia patients postoperatively including lipid total parenteral nutrition for those with prolonged postoperative ileus. Though available at MTRH since the 2015 study by Gachini, the supply and availability of parenteral nutrition, though not always continuous, has significantly improved. This could explain the slight difference in mortality rates associated with intestinal atresia reported in this study and the latter study.

Occurrence of surgical complications in the management of any surgical condition across all age groups has been an exigent predictor of associated mortality. In this study presence of a surgical complication reflected a 10.9 higher chance of mortality compared to those without complications. In a study of bowel resections encompassing all age groups, hospital length of stay exceeding two weeks was associated with increased surgical complication rate and mortality.[26] Mortality was reported in 34.6% of patients who had perioperative surgical complications and only three who had no surgical complications.[8]

This study assessed in hospital death attributable to mechanical intestinal obstruction at MTRH during the study period. Several other studies assessed in hospital death.[19,23,27,28] A met analysis assessing post admission deaths in countries characterized by low resources indicate that for all pediatric patients, post hospital admission mortality rates far exceed in hospital mortality rates; most of which occur within a short period after discharge from the hospital.[29] In Sub-Sahara Africa, post-operative follow up after discharge from hospital, including those patients where colostomies were done was only at 11% of the study population; it was unclear to the study researchers whether the cohort of patients sought further surgical care elsewhere or if they encountered out of hospital mortality.[3] In this study, sequel of surgical interventions such as creation of stomas were not assessed. This could suggest that the mortality that is due to childhood mechanical intestinal obstruction, within the pediatric surgical population at MTRH, in the long term, could be higher than 10.2%.

The limitation of the study is that sequel of management in children with mechanical intestinal obstruction was not explored. These include outcomes of procedures performed in the course of surgical management such as stoma fashioning or extensive bowel resection leading to short bowel syndrome and subsequently malnutrition. Studies are with longer study periods are encouraged to look into the burden of long-term effects of management to reflect the overall surgical complication and mortality rate.

CONCLUSION

In conclusion, surgical complication and mortality rate attributable to childhood mechanical intestinal

obstruction is still high in resource limited health care systems more so in neonates than older children. Misdiagnosis and delayed referral to pediatric surgical centers were some factors associated with high complication rate and mortality. Knowledge enhancement among healthcare workers on the non-classical symptoms of childhood mechanical intestinal obstruction is therefore recommended to aid in earlier presentation.

ACKNOWLEDGEMENTS

Authors would like to thank to Moi university department of surgery and anaesthesiology and the Moi teaching and referral hospital department of paediatric surgery.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee no. 003974 and national commission for science, technology and innovation (NACOSTI) (Research license number 89670).

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Cite this article as: Agade IW, Saula PW, Maiyo F. Early surgical outcomes of children with mechanical intestinal obstruction at Moi teaching and referral hospital, Kenya. Int Surg J 2024;11:1590-7.