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Research Article

Congenital Musculoskeletal Anomalies: Prevalence, Patterns, and Risk Factors within Southwestern Uganda-

Mohamed A Hersi[1], Michael J Flores[2], Kelsey E Brown[3], Adrienne R Socci[4], Deus Twesigye[1], and Daniel K Kisitu[1]*

[1]*Department of Surgery, Mbarara University of Science and Technology, P.O. Box 1410, Mbarara, Uganda*
[2]*Yale School of Medicine, 333 Cedar Street, New Haven, CT 06510, USA*
[3]*Warren Alpert Medical School of Brown University, 222 Richmond St, Providence, RI 02903, USA*
[4]*Department of Orthopaedics and Rehabilitation, Yale School of Medicine, 800 Howard Ave, New Haven, CT 06520, USA*

***Address for Correspondence:** Daniel K Kisitu, Department of Surgery, Mbarara University of Science and Technology, P.O. Box 1410, Mbarara, Uganda, Tel: +256-203-785-2579; E-mail: kisitukd@yahoo.com

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ABSTRACT

Introduction: Congenital Musculoskeletal Anomalies (CMA) constitute a major portion of congenital anomalies worldwide, second only to central nervous system anomalies. CMA has far-reaching effects on quality of life, often causing visible defects, disability, and emotional distress. These disparities are especially prevalent in Low- and Middle-Income Countries (LMICs), where access to care is limited. The current study describes the prevalence, patterns, and risk factors of CMA in Southwestern Uganda.

Materials and Methods: A descriptive cross-sectional study was conducted among pediatric patients presenting with CMA at the Mbarara Regional Referral Hospital and Ruharo Mission Hospital in Southwestern Uganda during a four-month period (February-May 2019). Data regarding demographics, CMA type, and CMA characteristics were obtained using a structured closed questionnaire approach, which was written first in English and then translated into a common local Ugandan language, Runyankole. All data were analyzed using Stata15. Bivariate and multivariate logistic regression were used to determine associations, with the level of significance set at 0.05.

Results: A total of 2,305 children were seen during the study period. From these patients, 257 (11.1%) CMAs were identified, with some patients having more than one CMA. The most common presentation of CMA was a male child less than 4-years old who was delivered vaginally. Congenital Limb Anomalies (CLA) constituted the majority of CMA, with lower limbs being the most affected (139 cases; 51%), followed by the upper extremities (38 cases; 18%). Ninety-three children (31%) had anomalies affecting the spine. The most common anomalies were Congenital Talipes Equinovarus (CTEV) (89 cases; 34.6%), spina bifida (78 cases; 30.4%) and polydactyly (15 cases; 5.8%). A family history of CMA was significantly associated with an increased risk of CMA ($p < 0.05$). Maternal education, antenatal care, and maternal medication use decreased the risk of CMA ($p < 0.05$).

Conclusion: This study demonstrates that over 11% of children presenting to the hospital in Southwestern Uganda have CMA, with CTEV and spina bifida being the most common. Based on the associations included in the current study, it is recommended that mothers with a positive family history of CMA have antenatal screening for birth defects. Additionally, further efforts to increase equitable access to antenatal care should be pursued.

Significance: This is one of the first studies to document the prevalence and patterns of CMA in Southwestern Uganda. Additionally, this study identifies multiple modifiable risk factors for CMA. Thus, this work provides helpful data for both policy makers and healthcare providers to decrease CMA prevalence and increase understanding of CMA in Uganda.

Keywords: Global surgery; Orthopedics; Outcomes; Rural; Trauma

INTRODUCTION

A congenital anomaly is defined as an abnormality of structure, function, or body metabolism present at birth that results in death or physical/mental disability [1]. Congenital anomalies affect between 1-2% of live births, with 10% of these being upper-limb deformities [2]. The WHO has reported that congenital anomalies rank 17th in causes of disease burden [3]. Although the etiology of congenital abnormalities is approximately 50%, they sometimes can be directly linked to genetic factors (30-40%) or environmental factors (5-10%), such as drug ingestion and certain maternal diseases during the first trimester of pregnancy [4,5].

A Congenital Musculoskeletal Abnormality (CMA) is a structural congenital abnormality of muscle and/or bone that affects the extremities and/or vertebral column [6]. CMA constitutes a major portion of congenital anomalies worldwide. In the field of orthopedics, patients with CMA are commonly encountered, often presenting with Congenital Limb Anomalies (CLA). In these cases, the upper and lower extremities are affected to varying degrees and multiple anomalies in the same patient is not rare. Additionally, CMA patients may have associated anomalies, such as a Ventricular Septal Defect (VSD), an Atrial Septal Defect (ASD), and/or an imperforated anus [7].

In Africa, malnutrition, infectious diseases, and inadequate medical facilities have additionally been associated with the increased occurrence of congenital anomalies [8]. CMA has far-reaching effects on quality of life for these patients, often causing visible defects, disability, and emotional distress [9,10]. This can create a large burden on personal, societal, and family relationships. Oftentimes, productivity of the patient is seriously impaired, and if not treated, the patient can be completely dependent on others for activities of daily living [11]. Traditional beliefs about children born with visual anomalies, such as club foot, can place shame and rejection on the mother and/or child [12].

CLA, specifically club foot, has been cited as the most frequently observed CMA in Sub-Saharan Africa [13]. Although various studies have identified the prevalence of congenital anomalies worldwide, little is known about the prevalence of CMA and the patterns associated with it in Uganda [14-16]. The aim of the current study is to gain insight into the prevalence, patterns, and risk factors of CMA in Uganda.

METHODS

A descriptive cross-sectional study was conducted among patients who attended the orthopaedic, neurosurgery, or plastic surgery clinics at the Mbarara Regional Referral Hospital and Ruharo Mission Hospital of Mbarara, Uganda during a four-month period between February-May 2019. All patients less than 18 years old who visited the selected study hospitals were screened for CMA. All patients less than 18 years old who had confirmed CMA, and whose guardian provided consent, were included in the study. Patients with cranio-facial abnormalities were excluded since the anomalies did not involve the limb or spine, and thus were not considered to be musculoskeletal.

Study procedures

Socio-demographic characteristics such as age, social status, family history and area of residence were recorded. A detailed examination was performed to document all abnormalities. Patients were assessed by the principle investigator through history and physical examinations, including vital signs, musculoskeletal examination, and if indicated, imaging was done (e.g. limb X-ray). Anomalies were grouped by organ system. Data was collected using pen and paper questionaires and stored in an excel spreadsheet.

Statistical analysis

Data were analyzed using Stata 15 (College Station, Texas). Baseline characteristics were summarized as continuous data

variables by mean, standard deviation, proportion, and percentage. Associations between variables were assessed using logistic regression in bivariate and multivariate models. A p-value less than 0.05 was considered statistically significant.

Ethics

Written informed consent was obtained from each patient's parent. Study protocols and procedures were reviewed and approved by the faculty of medicine research committee, Mbarara University of Science and Technology research commitee, Mbarara Regional Referral Hospital, and Ruharo Mission Hospital before study commencement.

RESULTS

A total of 2,305 patients under the age of 18 were seen at the study sites from February to May 2019. Out of these patients, 257 (11.1%) were identified as having one or more CMA. There were more male (146, 56.8%) than female (111, 43.2%) patients. The mean age of the participants was 29.04 ± 36.34 months. Most patients were born at term (93.4%) and were vaginally delivered (85.2%). While most (79.8%) of the patient's CMA was identified at birth, 10.1% were identified before the patient reached 6 months of age and 8.9% were identified after 6 months of age. The majority of patients (51.7%) lived an average distance of more than 50 km (31 miles) from the hospital. Most mothers had received a secondary school or higher education (49%). The two most common maternal occupations were housewife and farmer (Table 1).

There were 257 cases of CMA documented. Congenital Limb Anomalies (CLA) constituted the majority of CMA, with 164 cases (63.8%). Of CLA cases, the lower limbs were the most affected (126 cases; 49%), followed by anomalies of the upper extremities (38 cases; 14.8%). The most common CLA affecting the lower limbs was Congenital Talipes Equinovarus (CTEV) (89 cases, 52.4%), which was the most common CLA overall, followed by genu valgum (8 cases, 4.9%). The most common CLA affecting the upper limbs was polydactyly (15 cases, 9.1%), followed by syndactyly (8 cases, 4.9%) and arthrogryposis (5 cases, 3.0%) (Table 2). Of the 164 patients with CLA, 126 (76.8%) had bilateral anomalies, mostly in the lower limbs (126 patients, 76.8%), as shown in the table 3.

Additionally, there were 93 cases (36.2%) of CMA affecting the spine. Of spine patients, spina bifida was the predominant deformity seen (90 cases, 96.8%) and was also the most common CMA observed in the study overall (35%). A full description of all CMA cases can be seen in table 2.

Most mothers were between 25 and 35 years old. Most mothers had completed primary school (46%). The majority of mothers (83%) sought antenatal care during the time they were pregnant with their child with CMA. There were 57% of mothers that reported having a positive family history of any type of CMA. Out of all mothers, 13% took teratogenic medications during their pregnancy. Taking teratogenic medications for days was most common in this group of mothers. Only 4% of mothers reported smoking cigarettes during their pregnancy.

The bivariate analysis revealed that a family history of CMA was significantly associated with an increased incidence of CMA in the current study population, as shown in tables 4 & 5 (COR = 2.04; 95% CI: 1.20 - 2.12; $p = 0.008$). Additionally, maternal antenatal care and education level were significantly associated with a decreased incidence of CMA (COR = 0.43; 95% CI: 0.19 - 0.94, $p = 0.036$).

Table 1: Demographic characteristics of the study population.

Characteristic	N (%)
Patient Demographics	
Gender	
Female	111 (43.2)
Male	146 (56.8)
Age (Years)	
0 - 4	222 (86.4)
5 - 9	31 (12.1)
10 - 14	3 (1.2)
15 - 17	1 (0.4)
Gestational Age at Birth	
Preterm	8 (3.1)
Term	240 (93.4)
Post term	9 (3.5)
Mode of Delivery	
Vaginal	219 (85.2)
C-section	38 (14.8)
Age of CMA Detection	
Prenatal	3 (1.2)
Birth	205 (79.8)
0 - 6 Months	26 (10.1)
6 Months	23 (8.9)
Distance to Hospital (Km)	
< 10	21 (8.2)
10 - 20	22 (8.6)
20 - 30	10 (3.9)
30 - 40	23 (8.9)
40 - 50	48 (18.7)
> 50	133 (51.8)
City of Residence	
Mbarara	37 (14.4)
Isingiro	35 (13.6)
Ntungamo	29 (11.3)
Kasese	27 (10.5)
Bushenyi	27 (10.5)
Sheema	19 (7.4)
Other	83 (32.3)
Maternal Demographics	
Education Level	
No formal education	29 (11.3)
Primary school	102 (39.7)
Secondary school or higher	126 (49.0)
Occupation	
Housewife	101 (39.3)
Farmer	58 (22.6)
Business	31 (12.1)
Student	48 (18.7)
Other	19 (7.4)

In the multivariable analysis, maternal education level and antenatal care were shown to have a protective effect from CMA. Family history of CMA and teratogenic medication use during pregnancy was significantly associated with the occurrence of CMA.

DISCUSSION

Prevalence of CMA

The prevalence of CMA amongst patients presenting to our study sites 11.1%. Another study conducted in Entebbe, Uganda showed a comparable prevalence of CMA at 7.6% [17]. Additionally, studies conducted in other LMICs with similar study design and methodology, such as in India [6] and Iran [18], reported the prevalence of CMA as 7.1% and 9.3%, respectively. However, the prevalence in the current study was lower than that of studies carried out in other African studies, such as in Ethiopia [19] and Uganda [20], as well as in Iraq [21]. The variations in the results between these various studies may be due to differences in study settings, study design, inclusion criteria, and variations in terms of exposure to risk factors (behavioral, environmental, and/or genetic factors). Some

Table 2: Pattern and proportion of CMA.

Anomalies	N (%)
Hand	
Polydactyly	15 (5.8)
Syndactyly	8 (3.1)
Macrodactyly	1 (0.4)
Amniotic band constriction	1 (0.4)
Forearm	
Arthrogryposis	5 (1.9)
Synostosis	3 (1.2)
Amelia	2 (0.8)
Amelia with constriction band	2 (0.8)
Hemimelia	1 (0.4)
Hip	
Hip dislocation	2 (0.8)
Knee	
Genu valgum	8 (3.1)
Genu varum	5 (1.9)
Genu recurvatum	3 (1.2)
Legs	
Tibia hemimelia	3 (1.2)
Constriction band	1 (0.4)
Foot	
Congenital Talipes Equinovarus (CTE)	86 (33.5)
CTE with arthrogryposis	2 (0.8)
CTE with constriction band	1 (0.4)
Polydactyly	4 (1.6)
Metatarsus adductus	7 (2.7)
Syndactyly	3 (1.2)
Hallux varus	1 (0.4)
Spine	
Spina bifida	90 (35.0)
Scoliosis	2 (0.8)
Kyphoscoliosis	1 (0.4)

Table 3: CLA symmetry.

Limb Defect	Total	Unilateral	Bilateral
Upper limb	38	21	17
Lower limb	126	17	109

Table 4: A bivariate analysis of CMA risk factors.

Variable	COR (95% CI)	*p* - Value
Maternal Age		
20 - 25 yrs.	1.8 (0.64 - 5.39)	0.259
25 - 35yrs	2.5 (0.88 - 7.18)	0.084
> 35 yrs.	2.2 (0.47 - 11.00)	0.303
Maternal Education Level		
Primary school	1	
Secondary school and higher	0.56 (0.33 - 0.96)	0.034*
Parity of Mother		
Prim gravid	1	
Multi-gravid	1.1 (0.63 - 1.98)	0.715
Maternal Antenatal Care (ANC)		
Never attended	1	
Attended	0.43 (0.19 - 0.94)	0.036*
Family History of CMA		
No	1	
Yes	2.04 (1.20 - 3.44)	0.008*
Maternal Folic Acid Use		
Yes	1	
No	0.65 (0.38 - 2.12)	0.125
Teratogenic Medication Use		
Yes	1	
No	0.54 (0.29 - 0.98)	0.042
Teratogenic Medication Duration		
Days	1	
Weeks	6.4 (1.20 - 34.41)	0.03*
Months	3.7 (0.72 - 19.39)	0.115
Maternal Cigarette Smoking		
No	1	
Yes	1.0 (0.05 - 11.72)	0.913

*Statistically significant (significance set at < 0.05).

Table 5: A multivariate analysis of CMA risk factors.

Variable	AOR (95% CI)	*p* - Value
Maternal Education Level	0.39 (0.2 - 0.75)	0.005*
Antenatal Care (ANC)	0.26 (0.10 - 0.68)	0.006*
Family History	2.5 (1.22 - 5.11)	0.012*
Teratogenic Medication Use	0.49 (0.25 - 0.96)	0.039*

*Statistically significant (significance set at < 0.05).

studies indicated that the prevalence of CMA varies from country to country due to differences in the methodology used by researchers, for instance, population-based and hospital-based studies [22].

Patterns of lower limb CLA

In the current study, lower limb anomalies were found to be the most common CMA, with most of these cases being Congenital Talipes Equinovarus (CTEV), also known as club foot. Similar findings have been reported in other LMICs in Africa, including in Zambia [23] and Nigeria [24]. However, a one study conducted in Uganda showed lower rates of club foot [25]. This is likely due to the fact that the study identified club foot at birth only in regional hospitals, while many give birth outside of the hospital and present later. Additionally, one study in Shanghai, China [26] showed slightly increased rates of lower limb CLA compared to what was seen in this study. This could be due to an increased sample size in China. Another factor could be due to genetic or environmental variations between the countries. Additionally, the results for the current study were different from Western literature, which has reported upper limb CLA as being more prevalent when compared to lower limbs [27,28]. This difference could be attributed partly to the different sampling techniques, inclusion criteria, and genetic and/or environmental factors [29].

Patterns of upper limb CLA

In this study, there were 38 cases of upper limb CLA. The most common malformations affecting the upper limbs were polydactyly and syndactyly. A similar study done in India [6] found a similar prevalence as in the current study. Another study done in the Netherlands [28] reported that the most common abnormality effecting the upper limbs was polydactyly, as in the current study, but they found that the upper limbs were more commonly affected by CMA compared to the lower limbs which is inconsistent with the results of the current study. As stated above, this discrepancy could be due to the various differences in genetic and/or environmental factors.

Patterns of spine CMA

Spine deformity was the second most common form of CMA, although spina bifida was the most common CMA overall. Additionally, 40% of the spina bifida patients also had club foot, the second most common condition overall. The prevalence of spina bifida in the current study differs compared a study done in Algeria [30], however that study had a longer study duration period and was only looking neural tube defects.

Risk factors of CMA

A significant association was observed between having a familial history of CMA and the risk of developing CMA in this study. These findings are consistent with other African studies, including one study conducted in Egypt [31]. As some CMAs, such as polydactyly, have known autosomal dominat inheritance patterns, it makes sense that positive family history would be associated with increased risk of CMA [32]. Consanguinity is another potential explanation for the link between family history of CMA and risk of developing CMA. Two studies in Iran found the rate of congenital anomalies tended to be higher in offspring of consanguineous relationships than that of non-consanguinous relationships [33,34].

Additionally, the current study found that mothers with secondary education or higher, as well as those who attended antenatal care, had a lower occurrence of CMA. This finding was consistent with a study conducted in Saudi Arabia [35]. This is likely due to the fact that educated mothers and those that attend antenatal care were more aware of the steps they needed to take in order to avoid CMA. However, another study conducted in Tehran also showed linkage of maternal education and parity with the occurrence of CMA [36].

Finally, the current study found that cigarette smoking was not associated with CMA. In contrast, a study done in the United States of America [37] reported that cigarette smoking was associated with CMA. However, it should be noted that cigarette smoking is not common among women in Uganda.

LIMITATIONS

There were several limitations to this study. This study was a hospital-based survey, which cannot ensure accuracy similar to general population-based studies. Therefore, our reported prevalence of CMA may be higher than the general population. Another limitation is that the study was conducted over a short period of time. Data collected for a longer period of time could have better captured the true prevalence of CMA within patients presenting to these hospitals.

CONCLUSION AND RECOMMENDATIONS

The current study has shown that 11.1% of children in southwestern Uganda present with CMA to Mbarara Regional Referral Hospital and Ruharo Mission Hospital, with term, vaginally born males being the most common presenting features and with maternal education and antenatal care being important preventative factors. A family history of CMA and maternal teratogenic medication use are significantly associated with an increased risk of developing CMA. Musculoskeletal anomalies occur more often in the lower limbs compared to the upper limbs, with club foot and polydactyl being the most common. Spina bifida is the most common anomaly in the spine presenting to these hospitals. Without prompt medical attention, these children may have high disease burden and lifelong morbidity.

We recommend that all health care providers overseeing neonatal delivery and care should be trained and encouraged to thoroughly assess newborns for CMA. Prenatal visits are recommended for all mothers, particularly those having close relatives with congenital defects. These patients should consult with their health care provider and get an ultrasound during pregnancy. Further studies are required to determine the exact etiology and predictor variable of CMA, and our findings could help establish a database for further investigations.

ETHICAL APPROVAL

This study was approved by the Mbarara University of Science and Technology Research Ethics Committee. Furthermore, we certify that this study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

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