Sirenomelia of Postnatal Diagnosis about a Fresh Stillborn

Dr. Md. Hasan Moshiur Shawon[1], Dr. Md. Romzan Ali[2], Dr. Ishtiaq Ahmed[2], Dr. Rajib Paik[3], Dr. Subrata Roy[4]

[1]MBBS, MD (Pediatrics), Junior Consultant, District Hospital, Pirojpur, Bangladesh

[2]MBBS, Medical officer, District Hospital, Pirojpur, Bangladesh

[3]MBBS, DCH, Medical officer, District Hospital, Pirojpur, Bangladesh

[4]MBBS, FCPS (Pediatrics), MD (Pediatric Nephrology), Senior Consultant Pirojpur District Hospital, Pirojpur, Bangladesh

DOI: https://doi.org/10.51244/IJRSI.2024.11150036P

Received: 28 September 2024; Revised: 10 October 2024; Accepted: 15 October 2024; Published: 14 November 2024

ABSTRACT

Sirenomelia is a sporadic and regularly lethal birth defect characterized by the partial or complete fusion of the lower limbs, genitourinary anomalies, and pulmonary malformations. The exact causes are unknown, but several risk factors have been identified, including maternal diabetes mellitus, teratogenic medicines, inheritable vulnerability, vascular hypoperfusion, cocaine use, exposure to tip water, and maternal age being less than 20 years or greater than 40 years. A preterm (35-weeker) low birth weight (2300 gm) baby was born from a 30-year-old non-consanguineous mother via cesarean section. The child had melded lower appendages with 10 toes, missing outside genitalia, and a single umbilical supply route. The baby was passed away after 30 minutes of birth. We could not find any risk factor for sirenomelia in this case. We recommend an early routine ultrasound anomaly scan in all pregnant women particularly for early detection and termination of pregnancy as the prognosis is guarded.

Key words: Oligohydramnios, Prenatal diagnosis, Sirenomelia, Viteline artery

INTRODUCTION

Sirenomelia, also known as mermaid syndrome, is a congenital deformity characterized by the fusion of the lower limbs, resembling the mythical mermaid. [1] Defined by Stevenson as “a limb deformity in which the normally paired lower limbs are replaced by a single midline limb,” it is named after the legendary Greek Sirens. [2] This rare and often fatal birth defect occurs with an incidence rate of 0.8–4 per 60,000 to 100,000 pregnancies. [3-5] The exact causes are unknown, but several risk factors have been identified, including maternal diabetes mellitus, teratogenic drugs, genetic susceptibility, vascular hypoperfusion, cocaine use, exposure to landfill water, and maternal age being less than 20 years or greater than 40 years. [6-9] It is more common in monozygotic twins and males. [4, 10] Associated anomalies include absent or ambiguous external genitalia, imperforate anus, rectal atresia, absent urinary bladder, single umbilical artery, renal agenesis, esophageal atresia, omphalocele, pulmonary hypoplasia, cardiac defects, diaphragmatic hernia, lumbosacral/pelvic bone abnormalities, and spina bifida. [11] Prenatal diagnosis can be achieved with sonography in the first trimester, identifying symptoms such as nuchal translucency, fused or single lower limb, renal agenesis, a single umbilical artery, and oligohydramnios. [12]

CASE PRESENTATION

A 30-year-old woman, gravida three, para three, with two healthy children aged eight and six years, was admitted for a cesarean section at 35 weeks gestation due to severe oligohydramnios and fetal distress. She had no personal or family history of diabetes and had only taken iron and folic acid supplements during pregnancy. The parents were non-consanguineous and reported no conditions or birth defects in their family history, nor was there any history of radiation exposure. The pregnancy was poorly monitored and prenatal assessment (Toxoplasmosis, rubella, HBV, HCV, and HIV, diabetes screening, triple test) was negative. An ultrasound

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XV October 2024 | Special Issue on Public Health

performed at 32 weeks gestation revealed oligohydramnios. The baby did not cry within the golden minute after birth and exhibited severe birth defects, necessitating transfer to the Special Care and Neonatal Unit (SCANU) of the District Hospital (secondary healthcare facility) for better management.

APGAR score was 4. The newborn was resuscitated for 20 minutes but unfortunately passed away due to cardiac and respiratory arrest. The newborn exhibited severe birth defects, including the fusion of the lower segment of the body below the pelvis into a single lower limb, with two feet fused posteriorly to form a single flipper-like foot with ten toes spread out in a fan-like pattern, characteristic of mermaid syndrome. The foot was oriented anteriorly relative to the trunk, and external palpation suggested the presence of two femurs and two tibias. The external genitalia were absent, making it impossible to determine the sex. Additionally, the newborn had an imperforate anus and no urinary meatus, along with a single umbilical artery. The upper part of the body appeared normal. Weight of the baby was 2300 gm, length was 50 cm, and OFC was 35 cm. Authorization for post-mortem examination was declined by the parents. The newborn was declared stillborn with third gender. The genetic study like karyotyping, SRY and WES genes was not possible in our setting.

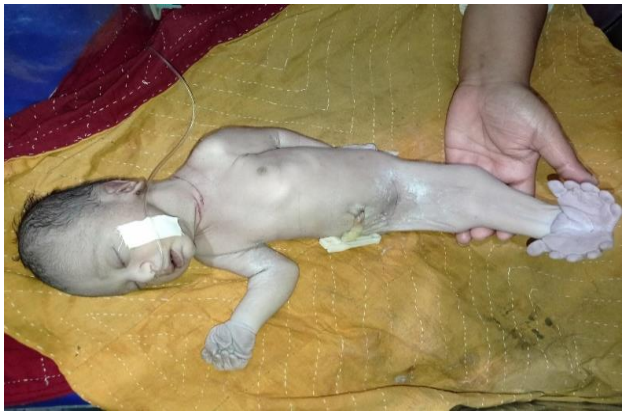

Figure 1: Complete morphological view of sirenomelic fetus.

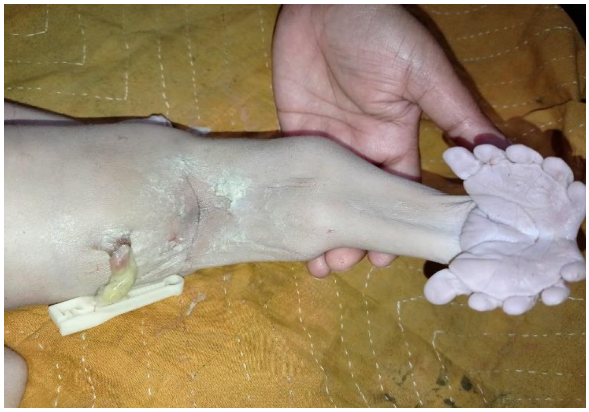

Figure 2: Photograph of the groin area showing no external genitalia and absent urinary meatus.

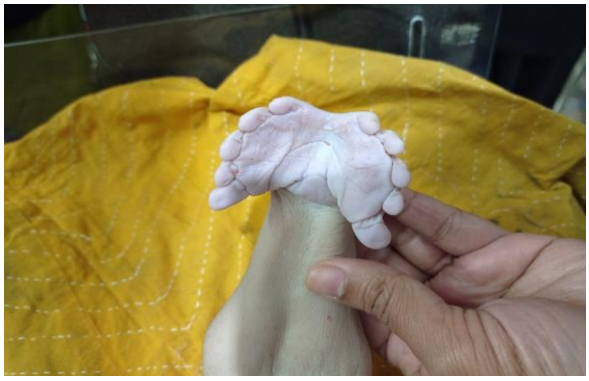

Figure 3: Photograph showing the fused feet with 10 toes.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XV October 2024 | Special Issue on Public Health

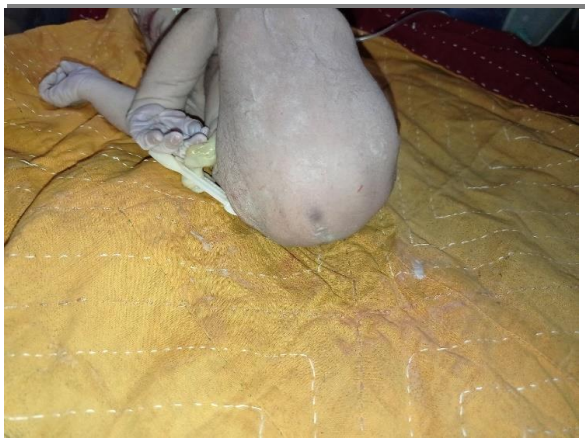

Figure 4: Posterior view showing fused lower limbs, imperforate anus.

INVESTIGATIONS

Infantogram:

Given that all thigh and leg bones are present, the newborn can be categorized as type 1 according to the Stocker and Heifetz classification of sirenomelia.

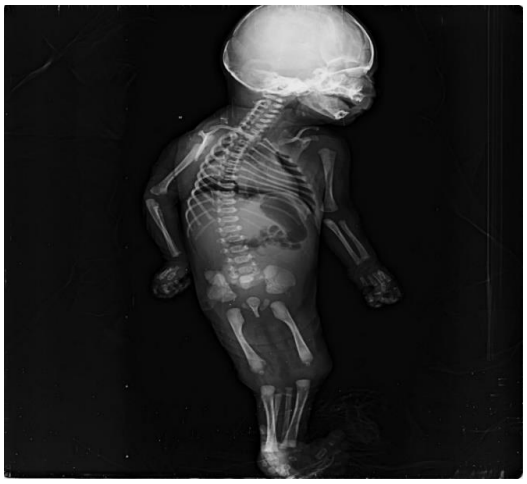

Figure 5: Infantogram

Ultrasonography

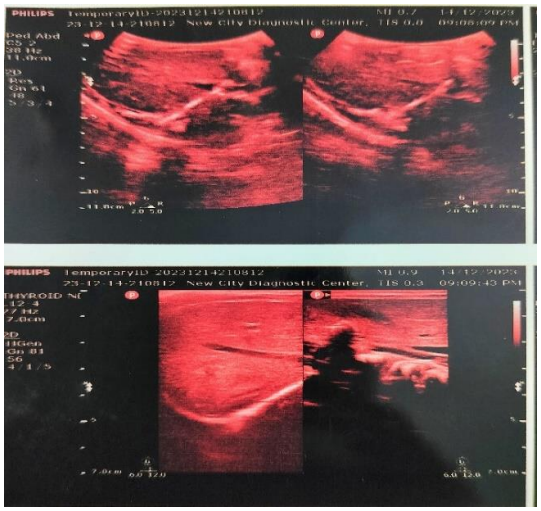

Figure 6: Ultrasonography revealed bilateral renal agenesis with absent urinary bladder.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XV October 2024 | Special Issue on Public Health

DISCUSSION

Sirenomelia is an extremely rare birth defect characterized by malformation of the gastrointestinal and genitourinary systems, fusion and skeletal abnormalities of the lower extremities, a single exceptional umbilical artery, and Potter's facies. [13] It was first reported in 1542 by Rocheus et al. and later by Palfyn et al. in 1543. In 1961, Duhamel classified mermaid syndrome (sirenomelia) as type 5 caudal regression syndrome (CRS). [14] However, nowadays, mermaid syndrome is considered a separate entity. The presence of two umbilical arteries, non-lethal renal anomalies, non-fused lower limbs, abdominal wall defects, and abnormalities of the tracheoesophageal tree, neural tube, and heart are key features of CRS. In contrast, sirenomelia is characterized by a single umbilical artery, bilateral lethal renal anomalies, and severe oligohydramnios associated with severe pulmonary hypoplasia. [11]

The exact etiology of sirenomelia is unknown. Researchers believe that both environmental and genetic factors may play a role in the development of this birth defect. Most cases appear sporadically, which suggests environmental factors or a new mutation. It is most likely that sirenomelia is multifactorial. In 1986, Stevenson proposed the theory of 'vitelline artery steal' to explain the development of sirenomelia. According to this theory, all patients with sirenomelia have a large umbilical artery that branches from the abdominal aorta slightly below the celiac artery. This abnormal vascular anatomy may lead to inadequate blood supply and nutrition to the lower part of the body during embryonic development. As a result, various malformations can occur, including sacral agenesis, fusion of the lower limbs, imperforate anus, rectal agenesis, internal and external genitalia anomalies, and renal agenesis. [15] Another proposed theory, based on 'defective blastogenesis', suggests that incomplete development of the caudal region and malformed lower limbs in sirenomelia result from ischemia due to defective angiogenesis during embryonic development. [16] These theories highlight the complex interplay of vascular anomalies and developmental abnormalities that contribute to the unique features of sirenomelia. The genetic basis of sirenomelia in humans remains largely unknown. While no specific chromosomal abnormalities have been identified as causing sirenomelia, [3] experimental studies on mice have provided insights into potential genetic mechanisms. Experiments inducing loss-of-function (LOF) mutations in the signaling sequences of the "bone morphogenetic protein" (Bmp-7) gene or gain-of-function (GOF) mutations in the signaling sequences of the "retinoic acid" (RA) gene have resulted in phenotypes similar to those observed in humans with sirenomelia. These include the fusion of lower limbs and severe pelvic malformations. [17] Poorly controlled maternal diabetes is indeed a recognized risk factor for sirenomelia, [13] although it only accounts for a small percentage of cases (approximately 0.5%–3.7%) reported in diabetic mothers. [18] The teratogenic effect is thought to be related to increased production of free oxygen radicals in maternal diabetes, which can interfere with normal embryonic development, potentially leading to anomalies like sirenomelia. [3, 4, 7, 16] It's notable that in many reported cases, maternal diabetes mellitus was not present, indicating that other factors may also contribute to the development of this birth defect. Additionally, maternal age below 20 years or above 40 years has been identified as another risk factor for sirenomelia. [19] This suggests that maternal age-related factors may also play a role in the incidence of this rare condition, although the exact mechanisms are not fully understood.

The recurrence pattern of sirenomelia is a topic of ongoing research and debate. Orioli et al. reported no familial recurrence in their study. [8] However, other studies have reported cases of true recurrence of sirenomelia within families, indicating a potential genetic component. [20, 21]

CLASSIFICATION

The most widely used sirenomelia classification system is that proposed by Stocker and Heifetz [18] (Table 1); therefore our case was assigned to category 1 (one).

Table 1: Sirenomelia classification by Stocker and Heifetz.

Type	Characteristics
I	All thigh and leg bones present
I	Single fibula

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XV October 2024 | Special Issue on Public Health

I	Absent fibula
V	Partially fused femurs, fused fibula
V	Partially fused femurs, absent fibula
I	Single femur, single tibia
I	Single femur, absent tibia

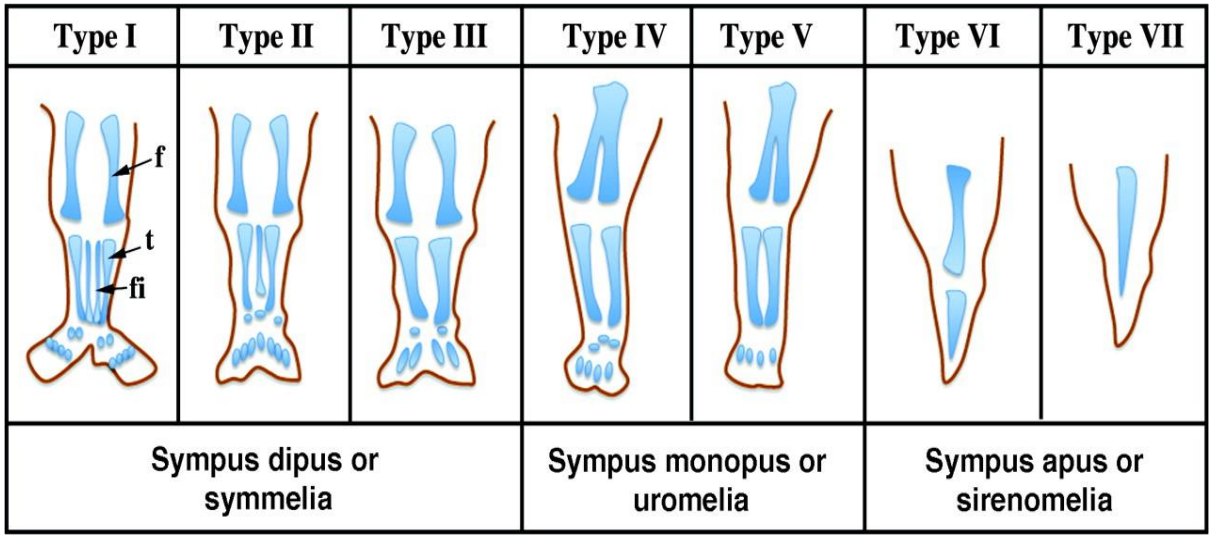

Figure 7. Schematic depicting the seven types of sirenomelia. Classification is according to Stocker and Heifetz. Alternative nomenclatures, used more frequently in the past, are indicated underneath. f, femur; fi, fibula; t, tibia. (Adapted from Stocker and Heifetz, 1987).

ANTENATAL DIAGNOSTIC TECHNIQUES

Diagnosing sirenomelia through antenatal ultrasound can be achieved as early as 14 weeks of gestational age. [22] Key ultrasound findings consistent with sirenomelia include nuchal translucency, the presence of a fused or single lower limb, renal agenesis, and a single umbilical artery. [12] During the second trimester, diagnosing sirenomelia becomes more challenging due to the development of oligohydramnios, which is often associated with renal agenesis or dysgenesis. Color and power Doppler ultrasound can aid in the diagnosis by showing a single greater vitelline artery. This artery typically originates from the proximal aorta, enters the iliac vessels without branching within the fetal pelvis, and connects to the umbilical cord ventrally. These specific Doppler findings can help differentiate sirenomelia from other conditions and assist in accurate prenatal diagnosis. [23]

PROGNOSIS

As sirenomelia is a serious birth defect and incompatible with life due to pulmonary hypoplasia and renal failure resulting from renal agenesis, medical termination of pregnancy is admissible. Approximately 50% of cases of sirenomelia result in live births, but most affected newborns do not survive beyond the first few days of life. In clinical practice, decisions regarding the management of pregnancies affected by sirenomelia involve careful consideration of medical ethics, parental wishes, and the anticipated outcomes for both the fetus and potential newborn. [4]

CONCLUSION

Sirenomelia remains a deadly condition with multisystem inclusion which makes this condition contradictory with life. Inquire about this region is missing due to separate cases happening each year around the world. More inquiry is required to get a way better understanding of the etiology and pathophysiology in arrange to avoid future cases and/or create antenatal/postnatal management to progress results.

REFERENCES

1. Al Yaqoubi HN, Al Badi MM, Ambu Saidi FM, Al Shafouri NST. A Case of Sirenomelia Associated with Hypoplastic Left Heart with a Healthy Co-Twin: A Rare Entity. Case reports in pediatrics. 2018; 9361745. https://doi.org/10.1155/2018/9361745
2. Siddiqui AF, Anjankar VP. Sirenomelia or "Mermaid Syndrome" in a Twin Pregnancy: A Case Report. Cureus. 2023; 15(1): e34311. DOI 10.7759/cureus.34311
3. Al Hadhoud F, Kamal AH, Al Anjari A, Diejomaoh MF. Fusion of lower limbs with severe urogenital malformation in a newborn, a rare congenital clinical syndrome: case report. Int Med Case Rep J. 2017; 10: 313–317.
4. Ramphul K, Mejias G, Ramphul-Sicharam Y. Mermaid syndrome: a case report in Mauritius. Cureus. 2018; 10(2): e2210.
5. Kavunga EK, Bunduki GK, Mumbere M, Masumbuko CK. Sirenomelia associated with an anterior abdominal wall defect: a case report. J Med Case Rep. 2019; 13(1): 213.
6. Kucuk S, Kucuk IG. Sirenomelia (mermaid syndrome). Turk J Pathol. 2020; 36(3): 256–260.
7. Turgut H, Ozdemir R, Gokce IK, Karakurt C, Karadag A. Sirenomelia associated with hypoplastic left heart in a newborn. Balkan J Med Genet. 2017; 20(1): 91–94.
8. Orioli M, Amar E, Arteaga-Vazquez J, Bakker MK, Bianca S, Botto LD, et al. Sirenomelia: an epidemiologic study in a large dataset from the international clearinghouse of birth defects surveillance and research, and literature review. Am J Med Genet. 2011; 157C (4): 358–73.
9. Tilahun T, Desta D. Successful expectant management of the anomalous fetus with sirenomelia in twin pregnancy: a case report and literature review. Int Med Case Rep J. 2021; 14: 229–232.
10. Sahu L, Singh S, Gandhi G, Agarwal K. Sirenomelia: a case report with literature review. Int J Reprod Contracept Obstet Gynecol. 2013; 2(3): 430–432.
11. Tamene A, Molla M. Sirenomelia: A case report. SAGE Open Medical Case Reports. 2022; 10. doi:10.1177/2050313X221092560
12. Akbayir O, Gungorduk K, Sudolmus S, Gulkilik A, Ark C. First trimester diagnosis of sirenomelia: a case report and review of the literature. Arch Gynecol Obstet. 2008;278(06):589–592
13. Garrido-Allepuz C, Haro E, Gonzalez-Lamuno D, Martinez-Frias ML, Bertocchini F, Ros MA. A clinical and experimental overview of sirenomelia: insight into the mechanisms of congenital limb malformations. Disease Models and Mechanisms. 2011; 4 (03):289–99. 10.1242/dmm.007732
14. Duhamel B. From the mermaid to anal imperforation: the syndrome of caudal regression. Arch Dis Child. 1961; 36 (186):152–155.
15. Stevenson RE, Jones KL, Phelan MC, Jones MC, Barr M Jr, Clericuzio C, et al. Vascular steal: the pathogenic mechanism producing sirenomelia and associated defects of the viscera and soft tissues. Pediatrics. 1986; 78(3):451–57.
16. Opitz JM, Zanni G, Reynolds JF Jr, Gilbert-Barness E. Defects of blastogenesis. Am J Med Genet. 2002; 115(04):269–286.
17. Gerard M, Layet V, Costa T, Roumazeilles Y, Chenal P, Cailliez D, et al. Sirenomelia and caudal malformations in two families[‡]. Am. J. Med. Genet. 2012; 158A: 1801-1807. https://doi.org/10.1002/ajmg.a.35408
18. Stocker JT, Heifetz SA. Sirenomelia. A morphological study of 33 cases and review of the literature. Perspect Pediatr Pathol. 1987; 10:7-50.
19. Chowdhury S, Kundu S, Manna SS, Das A. Both babies with sirenomelia' in twin pregnancy: a case report and review of literature. Int J Reprod Contracept Obstet Gynecol. 2015; 4(3):908–910.
20. Boer LL, Morava E, Klein WM, Schepens-Franke AN, Oostra RJ. Sirenomelia: a multi-systemic polytopic field defect with ongoing controversies. Birth Defects Res. 2017; 109(10):791–804.
21. Rudd NL, Klimek ML. Familial caudal dysgenesis: evidence for a major dominant gene. Clin Genet. 1990; 38(3):170-175.
22. Pandey D, Divedi P, Mishra PK, Mishra M. Sirenomelia: case report and discussion of its prenatal diagnosis. J Basic Clin Reprod Sci. 2014; 3(2): 133–135.
23. Patel S, Suchet I. The role of color and power Doppler ultrasound in the prenatal diagnosis of sirenomelia. Ultrasound Obstet Gynecol. 2024; 684-691. https://doi.org/10.1002/uog.1758