SLJFMSL

SRI LANKA JOURNAL OF FORENSIC MEDICINE, SCIENCE & LAW

Published biannually by the
Department of Forensic Medicine
Faculty of Medicine, University of Peradeniya
Sri Lanka

VOL. 16 Special Issue
May 2025
e-ISSN 2465–6089

Extended Abstracts of Forensic Medicine Postgraduate Research Sessions 2024
Organized by the Medical Education Resource Centre (MERC)
Postgraduate Institute of Medicine, University of Colombo, Sri Lanka

Sri Lanka Journal of
Forensic Medicine, Science & Law

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School of Computing, Engineering, and Physical Sciences
University of the West of Scotland
Scotland
ann-sophie.korb@uws.ac.uk
ORCiD: 0000-0002-4040-4750

Prof. Peter Juel Thiis Knudsen
Associate Professor
Deputy Chief Forensic Pathologist, Institute of Forensic Medicine
University of Southern Denmark
Denmark
pthiis@health.sdu.dk
ORCiD: 0000-0001-6385-0924

Prof. P.V. Ranjith Kumarasiri
MBBS, MSc, MD (Com. Med)
Professor in Community Medicine
Dept. of Community Medicine, Faculty of Medicine, University of Peradeniya
Sri Lanka
ranjith.kumarasiri@med.pdn.ac.lk
ORCiD: 0000-0002-6654-6167

Ms. Sriyani Perera
B.Sc (Pera), M.Phil. Chem (Pera), MA. Lib.Inf.Sc (Lond.),
Postgrad.Dip.Lib.Inf.Sc (Lond.)
Former Senior Assistant Librarian, Medical Library, Faculty of Medicine
University of Peradeniya, Peradeniya, Sri Lanka
sriyanip88@gmail.com
ORCiD: 0000-0002-3713-3304

Prof. Michael S. Pollanen
MD, PhD, FRCPath, DMJ (Path), FRCPC
Chief Forensic Pathologist, Ontario Forensic Pathology Service
Canada
michael.pollanen@ontario.ca
ORCiD: 0000-0002-8296-0333

Dr. Simon R. Stables MNZM
MBChB, DAvMed, AsFACAsM, FNZSP, FRCPA
Clinical Director, Northern Forensic Pathology Service, LabPlus
Auckland City Hospital
New Zealand
sstables@adhb.govt.nz
ORCiD: 0000-0003-4134-1496

Dr. Marianne Tiemensma
MBChB, Dip ForMed, FC ForPath, MMed (ForPath), PGDip (OccMed)
AHMP, FRCPA
Senior Forensic Pathologist, Forensic Science South Australia
South Australia, Australia
Flinders University, College of Medicine and Public Health
Adelaide, South Australia, Australia
Marianne.Tiemensma@sa.gov.au
ORCiD: 0000-0002-8437-6683

Prof. Amal N. Vadysinghe
MBBS, DLM, MD (Col.), D-ABMDI (USA)
Professor in Forensic Medicine
Dept. of Forensic Medicine, Faculty of Medicine, University of Peradeniya
Sri Lanka
amal.vadysinghe@med.pdn.ac.lk
ORCiD: 0000-0002-1994-7830

Prof. Noel W. Woodford
MBBS, LLM, DMJ(Path), FRCPA, FRCPath, MFFLM(UK), RCPathME
Professor of Forensic Medicine, Monash University
Director, Victorian Institute of Forensic Medicine
Australia
noel.woodford@vifm.org
ORCiD: 0000-0003-0297-1874

Editorial Office:
Department of Forensic Medicine
Faculty of Medicine
University of Peradeniya
Sri Lanka

Websites: **med.pdn.ac.lk**
sljfmsl.sljol.info

E-mail: **sljfmsl@med.pdn.ac.lk**
Tel: **+94 812 388083**

Cover Design & Typesetting: **Ms. Vinodani Dharmasena**

This journal is indexed in DOAJ, IMSEAR & NLM

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):1-5
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8020

ORIGINAL ARTICLE

ANALYSIS OF DIAPHRAGMATIC MORPHOLOGY AND CAUSE OF DEATH: AN AUTOPSY STUDY AT DISTRICT GENERAL HOSPITAL, KEGALLE, SRI LANKA

Nayakarathne NMTB[1]*, Vadysinghe AN[2], Wijerathne NASP[1], Ekanayake EMKB[2]
[1]*Office of the Judicial Medical Officer, District General Hospital, Kegalle, Sri Lanka*
[2]*Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka*

ABSTRACT

The lack of detailed morphology of the diaphragm limits the understanding of its pathological manifestations. Objective: The objective of this study was to assess the diaphragmatic morphology of the height, sex, age, and the organ systems involved in the cause of death (COD). This prospective cross-sectional autopsy study was conducted at the District General Hospital, Kegalle, Sri Lanka. Diaphragms, dissected using Letulle's technique at the autopsy, were measured for weight, anteroposterior (APD) and transverse (TD) diameters, costal and vertebral thicknesses, and the demographic features, body height and COD were recorded. The sample of 252 individuals consisted of 57.9% males, and the mean body height was 156.68 cm. Multiple comorbidities were recorded in 34.1% of the cases, and cardiovascular diseases contributed to 28.2% as COD, while the respiratory system and central nervous system contributed with 20.2% and 11.1% of cases, respectively. Means of weight, APD, TD, left and right costal thickness, and left and right vertebral thickness were 187.5 g, 19.4 cm, 33.1 cm, 1.6 cm, 1.6 cm, 2.7 cm, and 2.8 cm, respectively. All the diaphragmatic parameters showed positive linear correlations with body height. When the Kruskal-Wallis test was applied, males recorded higher mean rank values in diaphragmatic parameters, and the difference between the sexes was statistically significant. Diaphragmatic parameters showed statistically significant differences across age groups, with the youngest subjects recording higher values in diaphragmatic measurements. There were statistically significant differences across organ systems in all diaphragmatic parameters. Diaphragmatic measurements showed positive linear correlations with the subjects' heights, and males recorded higher values in diaphragmatic parameters than females. Values of the diaphragm measurements decreased with increasing age and showed significant differences across the organ systems involved in CODs.

Keywords: *Autopsy; diaphragm; morphology*

Corresponding author: Nayakarathne NMTB
tharanga.nayakarathne@yahoo.com
https://orcid.org/0000-0003-3232-3552

ARTICLE HISTORY
Received: 28.12.2024
Received in revised form: 09.02.2025
Accepted: 21.02.2025
Available online: 30.05.2025

INTRODUCTION

The diaphragm is a dome-shaped fibromuscular structure separating the thoracic and abdominal cavities. The most common pathologies of the diaphragm include hernias and phrenic nerve damage. The phrenic nerve is commonly damaged due to trauma or surgery. Compressive space-occupying lesions in the thorax, including mediastinal tumours, lung cancers, aortic aneurysms, substernal goitres, and cervical spondylosis, can cause diaphragmatic weakness due to phrenic nerve compression[1]. Many neurological and

inflammatory conditions will cause impairment of the phrenic nerve and diaphragmatic weakness[2]. Due to some diseases like emphysema, sarcoidosis, amyloidosis, and muscular dystrophy, the configuration of the diaphragm will be changed.

As discussed above, the diaphragm is one of the most important organs of the human body, and many disease conditions affect its morphology. However, in most routine autopsies, the diaphragm is not considered a major contributing organ in a death investigation[3]. This study aimed to emphasise the importance of the diaphragm in death investigation and improve the standards of autopsy practice.

OBJECTIVES

The main objective of this study was to assess the morphological pattern of the diaphragm in the Sri Lankan population. Specific objectives included the assessment of the morphology of the diaphragm related to the height, sex, age, and the organ systems involved in the cause of death (COD).

METHODS

This prospective cross-sectional study was commenced after obtaining ethical approval from the Ethics Review Committee of the Teaching Hospital, Kurunegala, Sri Lanka (Ref. No ERC/2022/15). All autopsies, where the deceased was 18 years and older, conducted consecutively during the period between the 1st of August and the 31st of December 2022, at the District General Hospital, Kegalle, Sri Lanka, were included. Foreign nationals, previously diagnosed individuals with congenital or acquired anatomical defects of the diaphragm, and putrefied bodies were excluded.

The height of the body was measured in centimetres. The diaphragm was dissected using Letulle's method. The weights, diameters, and thicknesses were measured in grams, centimetres, and millimetres, respectively. Data was analysed using IBM SPSS Statistics version 26. Associations between continuous variables were analysed using Spearman's correlation test, while associations between categorical variables were analysed using non-parametric tests, including the Mann Whitney-U test and the Kruskal-Wallis test. A 95% confidence interval was considered for all the statistical tests.

RESULTS

The study sample consisted of 252 deaths, comprising 146 males (57.9%). The mean height of the study sample was 156.68 cm.

Table 1: Descriptive statistics of the morphology of the diaphragm

Parameter	Mean	Standard deviation	Mini-mum	Maxi-mum
Weight(g)	187.5	49.508	106	322
Diameter(cm)				
Antero-posterior Diameter (APD)	19.4	1.725	15	24
Transverse Diameter (TD)	33.1	2.242	28	37
Thickness(mm)				
Costal thickness				
Left	1.6	0.471	0.8	2.9
Right	1.6	0.464	0.8	2.7
Vertebral thickness				
Left	2.7	0.657	1.3	4.3
Right	2.8	0.697	1.4	4.4

Table 2: Organ systems involved in the cause of death

Organ system	Cause of death, n (%)
Cardiovascular system (CVS)	72 (28.2)
Respiratory system (RS)	51(20.2)
Central nervous system (CNS)	28(11.1)
Gastrointestinal system (GIS)	12(4.8)
Genitourinary system (GUS)	10(4.0)
Musculoskeletal system (MS)	2(0.8)
Other	77(30.6)

Table 3: Correlation coefficients between the height and measurements of the diaphragm

Correlation with height		Spearman's rho	p-value
Weight (g)		0.598	<0.001
Diameter (cm)	APD	0.465	<0.001
	TD	0.472	<0.001
Costal thickness (mm)	Left	0.340	<0.001
	Right	0.025	0.694
Vertebral thickness (mm)	Left	0.259	<0.001
	Right	0.123	0.052

Table 4: Associations between diaphragmatic measurements and categorical variables

Variable		Sex		Age group		Organ system in COD	
Test		Mann-Whitney U	p-value	Kruskal-Wallis H	p-value	Kruskal-Wallis H	p-value
Weight (g)		2078.500	<0.001	102.208	<0.001	29.311	<0.001
Diameter (cm)	APD	4428.000	<0.001	108.863	<0.001	19.795	0.003
	TD	3717.000	<0.001	67.875	<0.001	37.332	<0.001
Costal thickness mm)	Left	4300.000	<0.001	76.705	<0.001	16.147	0.013
	Right	7245.000	0.386	27.590	<0.001	17.994	0.006
Vertebral thickness (mm)	Left	6500.500	0.030	69.922	<0.001	25.472	<0.001
	Right	6692.500	0.067	42.323	<0.001	27.331	<0.001

DISCUSSION

The current study demonstrated linear positive relationships between the height of the individuals and the diaphragmatic measurements. The mean values of the morphological characters assessed in this study were greater in men than in women, and the differences were statistically significant except for two parameters (Table 4). Differences in body dimensions between the sexes and hormonal activity may have played a role in the difference in morphology between males and females[4]. Younger populations showed heavier and larger diaphragms compared to the older, as indicated by the higher mean ranks obtained in the Kruskal-Wallis test, and these values gradually reduced as the age progressed.

Upon analysing the relationship between COD and diaphragmatic morphology, important insights emerge. The leading COD in this study was related to the cardiovascular system (Table 2). The weight of the diaphragm in association with cardiovascular COD was the highest among the mean ranks of organ systems when the Kruskal-Wallis test was used. It suggests that there could be a relationship between the two. It has been shown using animal models and ultrasound studies that the diaphragm may show adaptations to chronic heart failure[5,6]. Obesity, which is a risk factor for cardiovascular disease, is known to alter the morphology of the diaphragm, leading to its dysfunction[7,8]. Hence, it could be assumed that diaphragmatic morphology can be related to cardiovascular pathologies, but needs more research-based evidence.

Respiratory system-related CODs showed relatively higher mean ranks in diaphragmatic measurements. A previous study of breathing patterns in females showed significant differences in diaphragm thickness with breathing pattern disorders compared to control groups[7]. This indicates that acute and chronic diseases in the respiratory system are likely to cause functional and morphological changes in the diaphragm[9,10]. This may be the explanation for the findings of the current study.

CONCLUSION

Diaphragmatic measurements showed positive linear correlations with the subject's height, with males having higher values in

diaphragmatic parameters than females. Values of the diaphragm measurements decreased with increasing age. A significant difference was observed across the organ systems involved in the COD and diaphragm measurements.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The author declared no conflicts of interest.

DISCLOSURE

ANV and EMKBE are members of the Editorial Board of the Sri Lanka Journal of Forensic Medicine, Science & Law. Therefore, they did not participate in any way in the publication/decision-making process of this submission, as per journal policy.

ETHICAL ISSUES

The ethical approval for this study was obtained from the Ethics Review Committee of the Teaching Hospital, Kurunegala, Sri Lanka (Ref. No. ERC/2022/15).

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

NMTBN: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published. **ANV:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published. **NASPW:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published. **EMKBE:** Analysis, interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):6-9
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8018

ORIGINAL ARTICLE

A RETROSPECTIVE STUDY OF CARDIAC DEATHS REPORTED TO THE DEPARTMENT OF FORENSIC MEDICINE, UNIVERSITY OF PERADENIYA, SRI LANKA

Ekanayake EMKB[1]*, Devpura N[2], Vadysinghe AN[1], Daraniyagala DHU[1], Liyanage LPM[1], Jayasinghe SS[1]

[1]*Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka*
[2]*Department of Statistics, Faculty of Applied Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*

ABSTRACT

Cardiac pathologies contribute to a significant number of deaths every year worldwide. This retrospective descriptive study was to determine the associations between the sex, age, weight of the heart and the cause of cardiac death of deceased individuals who were subjected to medico-legal autopsies in a local setting. Data was collected by scrutinizing the postmortem data records available at the Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Sri Lanka, from 1st January 2017 to 31st December 2023. Using SPSS, descriptive analyses, ANOVA and binary logistic regression were employed to explore the associations between the variables. A total of 283 autopsy cases were considered, comprising 66.8% males. Among the subjects, 31.3% belonged to the age group of 70-79 years, followed by 29.3% from 60-69 years. Causes of cardiac deaths related to coronary artery pathologies contributed to 82.7% of the cases, with ischaemic heart disease (49.8%) and myocardial infarction (25.4%) being the most common. The ANOVA test showed a statistically significant difference between heart weight among the sexes ($p<0.001$), while heart weight showed a significant difference between the age groups of 50-59 and 80 and above ($p=0.016$). A binary logistic regression approach to exploring associations between age, sex, height, and heart weight with the causes of cardiac death (coronary vs. non-coronary) revealed a limited predictive power. Preventive measures and health education should be prioritized to minimize cardiac deaths, especially those due to coronary artery pathology. The importance of further research to improve the predictive modelling of causes of cardiac deaths is also highlighted.

Keywords: *Autopsy, coronary vessels, myocardial ischaemia*

Corresponding Author: Ekanayake EMKB
kasun1992eka@gmail.com
ORCID iD: https://orcid.org/0000-0003-2469-6244

ARTICLE HISTORY
Received: 25.12.2024
Received in revised form: 16.02.2025
Accepted: 17.02.2025
Available online: 30.05.2025

INTRODUCTION

An estimated 17.9 million people die from cardiovascular diseases (CVD) every year, which is the leading cause of death in the modern world[1]. When considering sex, many studies have shown that there are differences in the incidence of CVD, which can be attributed to structural and physiological differences[2]. It has also been shown that the incidence of cardiac death (CD) increases with age in both men and women since the prevalence of ischemic heart disease (IHD) increases with age[3].

The weight of the heart is often considered an indicator of cardiac pathology. In conditions such as hypertensive cardiomyopathy and hypertensive heart disease, the weight of the heart is increased because of symmetric or asymmetric ventricular hypertrophy[4]. Narrowing of the lumen of coronary arteries that supply the myocardium, due to atheromatous calcification can lead to chronic ischaemia and the development of an abnormal heart rhythm[5].

OBJECTIVES

The objective of this study was to determine the associations between the sex, age, height, weight of the heart and the cause of CD of deceased individuals who were subjected to medico-legal autopsies at the Department of Forensic Medicine, University of Peradeniya, Sri Lanka, from 2017 to 2023.

METHODS

This retrospective descriptive study was conducted by scrutinizing the postmortem data records available at the Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Sri Lanka, from 1st January 2017 to 31st December 2023. Collected data was analysed using IBM SPSS Statistics version 26. This study was exempted from ethics review (Ref. No. 2023/EC/70) by the Ethics Review Committee, Faculty of Medicine, University of Peradeniya.

RESULTS

A total of 283 autopsy cases were considered in this study, which consisted of 189 (66.8%) males and 94 (33.2%) females. The age ranged from 32 to 97 years, with a mean of 67.07. Most cases were reported from the 70–79 age group (89, 31.4%). Nearly three-fourths of the deaths (207, 73.1%) were among individuals over 60 years old. The mean height was 162.5 cm while the mean postmortem weight of the heart in the study sample was 370.6 g.

Table 1: Frequency of cause of death in the study sample

Cause of death	Frequency (%)
Ischaemic heart disease	141 (49.8)
Myocardial infarction	72 (25.4)
Haemopericardium	21 (7.4)
Hypertensive heart disease	16 (5.7)
Atherosclerotic heart disease	14 (4.9)
Coronary artery thrombosis	7 (2.5)
Valvular heart disease	6 (2.1)
Heart failure due to secondary causes	4 (1.4)
Cardiomyopathies	1 (0.4)
Acute pericarditis	1 (0.4)

The most common cause of death (COD) was ischaemic heart disease (IHD), which accounted for almost half of the sample, followed by myocardial infarction (MI), which consisted of a quarter of the cases (Table 1). In a broader classification, coronary vascular causes, including IHD, MI, atherosclerotic heart disease, and coronary artery thrombosis, accounted for 234 (82.7%) cases.

When the ANOVA test was applied to compare heart weights across age groups, there was a statistically significant difference ($p=0.021$) in heart weight between at least two age groups at a 95% level of confidence. Furthermore, Tukey's HSD test showed that the mean heart weight between the age groups of 80 years and above and 50-59 years showed a significant difference ($p=0.016$). Comparison of heart weight across the two sexes using ANOVA showed that there was a statistically significant difference in heart weight between males and females ($p<0.001$).

Binary logistic regression was used to explore associations between age, sex, height, and heart weight with the identified causes of CD (coronary vs. non-coronary). It revealed limited predictive power regarding the identified causes of CD as binary variables of coronary and non-coronary causes. Therefore the model's ability to distinguish between coronary and non-coronary causes of death would be limited.

DISCUSSION

In this study sample, two-thirds of the deceased individuals were males. It had been previously observed that there can be differences in the incidence of cardiac pathologies between males and females[2]. Similarly, in the Sri Lankan context, it has been observed that male CDs are more frequent[6], which was evident in this study as well. It had also been previously studied that males are likely to develop a cardiac disease as a first event, while females are more prone to developing heart failure or a cerebrovascular event first[7]. However, in the limited scope of this study, it was challenging to address that issue. In relation to the sex and the weight of the heart, the literature shows that males have heavier hearts[8], as was the case in this study as well.

Manifestations of cardiac disease are more likely to appear at older ages and therefore CDs are more common among the older age groups[7]. It has also been shown that, in both sexes, the incidence of CD increases with age, together with the prevalence of heart disease, and the peak of CD is between 45 and 75 years[3]. In our study also, the highest number of deaths and the peak were reported in similar age groups. Age is considered a factor that influences the weight of the heart[9]. Similarly, in our study, there was a significant difference between the weight and age of the subjects.

Weight of the heart is often associated with cardiac pathologies and death, especially in cardiomyopathies and hypertensive heart disease[4]. In our study, such an association could not be established, emphasizing the need for wider studies.

Previously published literature reviews on CD reveal that pathologies in coronary vasculature account for around 70-80% of all CD[10], which is also reflected in our study sample as well. However, the use of a binary logistic regression model was unsuccessful since it could not demonstrate significant associations between the COD and other variables. A reason for this issue could be that there might be individuals with more than one cardiac pathology present, but only one pathology had been documented as the COD, as the immediate COD in the World Health Organisation format for determining the COD in CDs.

CONCLUSIONS

The findings of the study revealed that the incidence of CDs is higher among males and in older age groups, while the coronary artery pathologies contributed to most of the CDs in the said sample. While the two sexes had significant differences in heart weight, only two age groups showed a significant difference in heart weight. The binary logistic regression approach to explore the association between age, sex, height of the deceased, and heart weight with coronary and non-coronary CODs showed poor predictive accuracy.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The author declared no conflicts of interest.

DISCLOSURE

EMKBE and ANV are members of the Editorial Board of the Sri Lanka Journal of Forensic Medicine, Science & Law. Therefore, they did not participate in any way in the publication/decision-making process of this submission, as per journal policy.

ETHICAL ISSUES

This study was exempted from ethics review (Ref. No. 2023/EC/70) by the Ethics Review Committee, Faculty of Medicine, University of Peradeniya.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

EMKBE: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **ND:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **ANV:** Conception and design of the work; the

acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **DHUD:** Acquisition, analysis, and interpretation of data for the work; revising; and final approval of the version to be published. **LPML:** Acquisition, analysis, and interpretation of data for the work; revising; and final approval of the version to be published. **SSJ:** Acquisition of data for the work; revising; and final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):10-13
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8037

ORIGINAL ARTICLE

SOCIODEMOGRAPHIC, BEHAVIOURAL, PSYCHOLOGICAL AND CONTRACEPTIVE ASPECTS AMONG VICTIMS OF SEXUAL ABUSE PRESENTED TO THE DISTRICT GENERAL HOSPITAL, KEGALLE, SRI LANKA - A RETROSPECTIVE STUDY

Kulathunga NP[1]*, Ekanayake EMKB[2], Wijerathne NASP[1]
[1]Office of the Judicial Medical Officer, District General Hospital, Kegalle, Sri Lanka
[2]Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka

ABSTRACT

Sexual abuse remains a significant health issue with psycho-social impacts on victims, which gives rise to the necessity of conducting focused research. The objective of this study was to retrospectively analyze the sociodemographic, behavioural, psychological, and contraceptive aspects of sexual abuse victims presented to the District General Hospital, Kegalle, Sri Lanka. Data was collected by scrutinizing the medico-legal examination records of sexual abuse victims presented to the District General Hospital, Kegalle, from 15/04/2024 to 01/10/2024 and analyzed using IBM SPSS Statistics version 26. The sample of 49 considered cases consisted of 42 females (85.7%) and 7 males (14.3%) with a mean age of 21.6 years. The perpetrators included relatives (28.6%), intimate partners (26.5%), guardians (14.3%) and in 12.2% cases the perpetrators were unknown. Evidence of physical abuse was present in 9 (18.3%) of cases, 8 (16.3%) of them being non-grievous. Among 44.9% of the victims, deranged family dynamics such as marital disputes among parents were noted. Features of psychological sequelae were observed in 32.7% of cases, with post-traumatic stress disorder (18.4%) and depression (14.3%) being the most common. Mental age was observed to be less than the documented chronological age in 14.3% of cases. Among the victims aged 13 years and above (n=39), 38.5% were aware of the contraceptive methods. This study highlights the involvement of familiar perpetrators, psychological impact, family dynamics and limited awareness of contraception, emphasizing the need for targeted intervention to minimize the ill effects of sexual abuse on victims.

Keywords: *Demography; physical abuse; sexual offences*

Corresponding Author: Kulathunga NP
nirakulathunganew@gmail.com
https://orcid.org/0000-0002-4510-0094

ARTICLE HISTORY
Received: 14.01.2025
Received in revised form: 17.01.2025
Accepted: 25.01.2025
Available online: 30.05.2025

INTRODUCTION

Sexual abuse is often a triggering event that leads to physical, social, and psychological impacts on the victim. In Sri Lanka, the incidence of sexual abuse has increased by 40% in the last 10 years[1]. According to the United Nations Population Fund, in Sri Lanka, one in every four women has been subjected to abuse by the time she reaches 15 years[2]. In the general population, 44% had experienced some form of sexual maltreatment in their life[3]. With this high prevalence, conducting studies on socio-demographic, behavioural, psychological, and contraceptive aspects is important to identify and prevent the adverse health effects and socio-economical and psychological impacts.

OBJECTIVES

The objective of this study was to retrospectively analyse the sociodemographic, behavioural, psychological, and contraceptive aspects of sexual abuse victims presented to the District General Hospital, Kegalle, Sri Lanka.

METHODS

Data was collected retrospectively by scrutinising the medico-legal examination records of sexual abuse victims presented to the District General Hospital, Kegalle, Sri Lanka, from 15th April 2024 to 01st October 2024. Collected data was analysed using IBM SPSS Statistics version 26.

RESULTS

A total of 49 cases were studied, with the mean age of the sample being 21.6 years. A majority of 55.1% (n=27) of the victims were in the age group of 13–18 years. In this sample, 42 (85.7%) victims were females. When the victim's relationship with the perpetrator was considered, it was noted that in 43 (87.8%) cases, the perpetrator was known to the victim (Table 1), which included relatives (14, 28.6%), intimate partners (13, 26.5%), and guardians (7, 14.3%). In addition to the sexual abuse aspect, physical abuse was present in 9 (18.3%) cases, with 8 (16.3%) being non-grievous and 1 (2.0%) case resulting in the death of the victim.

Table 1: Victim's relationship with the perpetrator

Relationship	Frequency (%)
Relative	14 (28.6)
Intimate partner	13 (26.5)
Guardian	7 (14.3)
Other	9 (18.4)
Unknown	6 (12.2)

In 22 (44.9%) of the cases, it was noted that the victims had been exposed to dysfunctional family dynamics in the past, such as marital disputes among parents. Psychological sequelae were observed in 16 (32.7%) cases, in the form of post-traumatic stress disorder (PTSD) (9, 18.4%), depression (7, 14.3%), anxiety (2, 4.1%), suicidal ideation (1, 2.0%), and confusion (1, 2.0%). In the sample, the mental age of the victim was observed to be less than the chronological age in 7 (14.3%) cases. When the 39 female victims who were aged 13 years and above were considered, 15 (38.5%) were aware of the use of contraceptives in preventing pregnancies.

DISCUSSION

Studies conducted by Perera in 2009 and Rohanachandra in 2021 have shown that most of the victims of sexual abuse are victims and teenagers, with 14% of males and females being subjected to some form of sexual abuse in Sri Lanka, while sexual harassment was as high as 78.5 %[4,5]. A study by Vadysinghe et al. conducted in the Central and Sabaragamuwa provinces of Sri Lanka showed that 96% of victims were female, and out of them, 81% were below the age of 18 years, with 71% of them being in schooling age[6]. In the current study also, most of the victims were female, and more than half of the victims were aged between 13 and 18 years. Hence, this study highlights the vulnerability of young females to sexual abuse. Furthermore, 14.3% of the victims recorded a lower mental age than their chronological age. This further highlights the fact that intellectual impairment can also increase the risk of sexual victimisation. Therefore, mental age assessment of sexual abuse victims is essential to comment on the victim's ability to express consent for sexual activity. The legal provisions for the mental age also need to be strengthened to include the sexual victimisation of adults with intellectual disabilities.

In this study, it was shown that in a large majority of the cases, the perpetrator of the sexual abuse was a known individual. This finding is compatible with the findings of previous studies by Rohanachandra[5], Vadysinghe[6] and Rathnaweera[7]. Furthermore, they highlight factors affecting the successful management of victims, such as delayed reporting and poor social support. This study also shows that in almost half of the cases, the victims had been exposed to marital disputes among their parents in the past. According to the available literature, children from

dysfunctional family environments are at a higher risk for sexual abuse[8]. Therefore, it should be noted that addressing family issues may not only prevent potential victimisation but also promote healthier developmental trajectories.

As most victims of sexual abuse are female, age-appropriate sex education and knowledge of contraceptives are important to prevent unnecessary pregnancies and adverse health effects. A study conducted among Sri Lankan youth trainees, including both males and females, showed that only 47.5% had ever heard of condoms, while only 13.2% knew about emergency contraceptive pills[9]. The need for implementing targeted health education for vulnerable groups is evident. Interventions such as the incorporation of reproduction health in school curricula and regular knowledge updates will be beneficial, especially for teenagers.

Psychological consequences following sexual abuse are well documented, and such sequelae include poor school performance, anxiety, PTSD, depression, suicide, and aggression[5,10], with similar observations being noted in the current study and highlighting the importance of adequate mental health management and follow-up.

CONCLUSIONS

This study highlights the involvement of familiar perpetrators, psychological impact, family dynamics, and limited awareness of contraception, emphasising the need for targeted intervention to minimise the ill effects of sexual abuse on victims.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

DISCLOSURE

EMKBE is a member of the Editorial Board of the Sri Lanka Journal of Forensic Medicine, Science & Law. Therefore, they did not participate in any way in the publication/decision-making process of this submission, as per journal policy.

ETHICAL ISSUES

This study was conducted using anonymized, retrospective data obtained from medico-legal documents with the permission of the Consultant Judicial Medical Officer at the District General Hospital, Kegalle, without the direct involvement of human participants. All data were handled with strict confidentiality and used solely for academic and research purposes in accordance with institutional guidelines and ethical standards.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

NPK: Conception and design of the work; the acquisition, analysis, interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published. **NASPW:** Conception and design of the work; the acquisition, analysis, interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published. **EMKBE:** Analysis, interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):14-18
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8017

ORIGINAL ARTICLE

UNNATURAL CHILDHOOD DEATHS IN TWO TERTIARY CARE HOSPITALS IN SRI LANKA: A RETROSPECTIVE STUDY

Siddique MS*, Vadysinghe AN, Kodikara KAS, Ekanayake EMNK
Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka

ABSTRACT

Unnatural mortality in children is a global issue that varies widely from country to country and within the regions of a country. Natural deaths are usually disease-related, but unnatural deaths (UD) are due to various external factors, which are usually preventable. This study aims to identify the risk factors for UD and its proportion, for which preventive measures can be adopted. UD in children reported to two tertiary care hospitals (National Hospital Kandy and Provincial General Hospital Kegalle) in Sri Lanka from 1st January 2020 to 31st December 2023 were analyzed. The study sample consisted of 333 deaths, of which the majority were natural. There were 237 (71.17.%) natural deaths and 96 (28.9%) UD. Among UD, 67.7% (65) were male children. Accidental deaths were higher than suicides. Out of suicidal deaths, 88.2% were due to hanging and 5.8% by drowning. Road traffic accidents (RTA) were the most common cause (48.4%) for accidental deaths, followed by falls, train accidents and drowning. The teenage group had sustained 72.2% of unnatural deaths out of all deaths. RTA, drowning and hanging were accountable for the majority of UD in Sri Lanka. Appropriate measures must be adopted to overcome these preventable deaths.

Keywords: *Children; risk factors; unnatural deaths*

Corresponding author: Siddique MS
sadsid71@gmail.com
ORCID iD: https://orcid.org/0000-0003-2909-2482

ARTICLE HISTORY
Received: 24.12.2024
Received in revised form: 26.03.2025
Accepted: 18.04.2025
Available online: 30.05.2025

INTRODUCTION

The death of a child is a sentinel event in a community and a defining marker of a society's policies of safety and health. An unnatural child death is a tragic outcome that can occur anywhere in the world. During the last century, child mortality has fallen to very low rates in developed countries. From a medical perspective, a natural death refers to a death that occurs solely due to a disease or natural processes. Unnatural deaths (UD) include homicide, suicide, and accidents. All of these cases are potentially preventable because the death occurs due to an external process. An understanding of the nature and patterns of childhood death and factors contributing to childhood deaths is essential to drive preventive initiatives[2].

The World Health Organisation (WHO) defines a child as a person less than 18 years old. Childhood is a critical phase of life with major physical, physiological, psychological, and behavioural changes, with changing patterns of social interactions and relationships. During this turbulent phase of life, young individuals are exposed to various needs, demands, challenges, failures, conflicts, and problems. This group will grow up to become fundamental contributors to the development of a country[3].
The global under-five-year mortality rate has significantly decreased over the past few decades. A 60% reduction reflects improvement in child health worldwide. Despite this progress in reducing child mortality, conditions such as pneumonia, diarrhoea, malaria, preterm **births,** and **intrapartum-related complications** remain, according to new mortality estimates released by the United Nations International Children's Emergency Fund (UNICEF) and the WHO Population Division[4]. In 2019, the child mortality rate for Sri Lanka was 7.1 deaths per 1,000 live births, after falling gradually from 70.1 deaths per 1,000 live births in 1970[5].

A medico-legal autopsy is an important solution to many unanswered questions that may arise after death. Information revealed after a child's death is mandatory to improve childhood survival and to strengthen child welfare services. Only a few studies have reported childhood factors associated with UD and risk factors at the individual level, family level, and community level. The majority of UD in literature were due to accidents, including road traffic accidents (RTA), falls from a height, snake bites, lightning, electrocution, animal attacks, drowning, poisoning, hanging, and burns[6,7].

OBJECTIVES

The main objective of this study was to understand the sociodemographic profile and types of unnatural deaths among children reported to two tertiary care hospitals in Sri Lanka, the National Hospital Kandy (NHK) and the Provincial General Hospital Kegalle (GHK).

METHODS

This was a descriptive study done retrospectively that included all UD among individuals under the age of 18 years. An electronic database was created for this study, retrieving data from the databases of the two hospitals (NHK and GHK) from the 1st of January 2020, to the 31st of December 2023. All deaths under the age of 18 were considered. The information retrieved from the new data system was sex, date of birth, address, history with remarkable events, time of death, details of the autopsy, lab investigations, and cause and manner of death. The data was analysed using the IBM SPSS Statistics software.

RESULTS

There were 23 UD at GHK for the given period and 72 UD at NHK. All the children above 5 years of age were attending school, whilst others were at pre-school or taken care of by their families. Among the UD, 67.7% (n=65) were male and 32.3% (n=31) were female. These UD consisted of 10.2% (n=34) suicides and 18.61% (n=62) accidental deaths. No homicides were reported (Fig. 1).

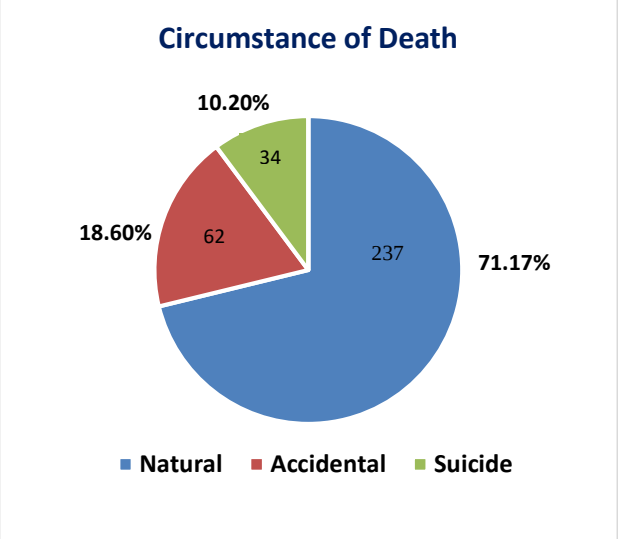

Figure 1: The distribution of natural and unnatural deaths (UD)

The majority of UD occurred among teenagers, accounting for 65 deaths, or 72.2% of the total. In the 3-to-12-year age group, there were 14 UD (15.5%), while among toddlers, 9 (10%) UD were recorded. UD were lowest among infants, with only 2 (2.2%) cases reported. In the analysis of suicides, the majority of children (88.23%) died from hanging (n=30), drowning (n=2) and other causes (n=2) (Fig. 2).

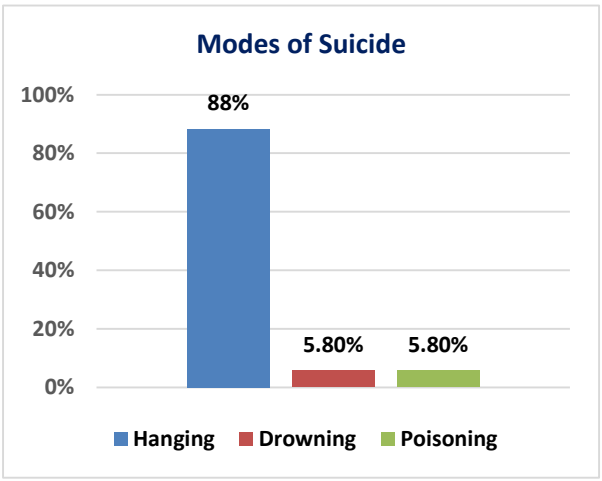

Figure 2: Modes of suicide

UD occurred under a variety of accidental circumstances. RTA were the most frequent, accounting for nearly half of the UD (41.6%). Falls were the second leading cause at 23.3%, followed by accidental drownings at 18.3%. Less common causes included train accidents (6.6%), burns (5%), and cut injuries (1.6%). The remaining 3.3% of UD were attributed to other causes such as poisoning, accidental sharp trauma, and asphyxia (Fig. 3).

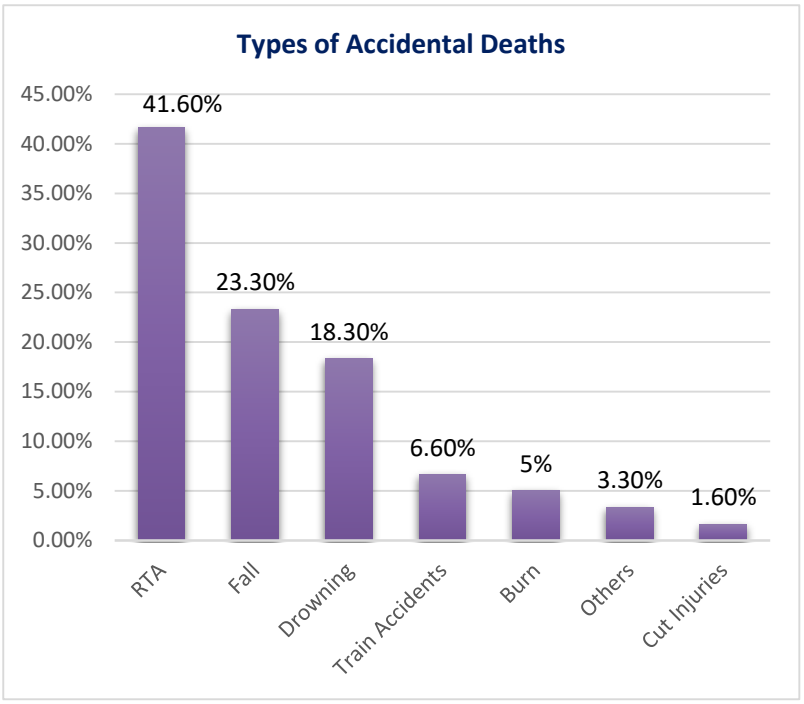

Figure 3: Different types of accidental deaths

DISCUSSION

Despite advancements in medicine, natural deaths remain the leading cause of death among both children and adults. Although natural causes remain a major contributor to child mortality in Sri Lanka, deaths from unnatural causes have increased over the last four years, principally due to hanging and RTAs[7].

This study revealed that 67.7% of male child deaths were UD. Male children have a higher tendency to undertake risky behaviours compared to their female counterparts. These findings are consistent with prior national studies conducted in the United States and Turkey. However, the underlying mechanisms driving this gender-based mortality disparity remain complex and not fully elucidated. Various biological and social factors, along with modifiable behaviours like substance abuse and violence, may play a significant role in the reduced life expectancy observed in male children[8].

Several interconnected factors contribute to female child mortality. These include emotional and social situations, such as romantic relationships, and psychosocial disturbances, including mental health issues like depression and anxiety, which also play a crucial role. Socioeconomic factors like poverty, family dynamics, domestic violence, neglect, peer pressure, and societal influence potentially create a vulnerable, high-risk environment for female children, placing them at a higher risk for UD[11].

The largest proportion of UD (72.2%) was observed among teenagers. In studies conducted in India and the United States, similar patterns have been observed [8].

In our study, accidental deaths constituted two-thirds of all unnatural deaths. These results are very similar to another study conducted in Sri Lanka by Kitulwatte et al[7].

Access to lethal means significantly influences suicide methods. Hanging is the most common method of suicide among teenagers globally, a trend also observed in Sri Lanka. A thorough understanding of suicidal behaviour in children is essential for developing effective prevention strategies. In a European context, the most common suicide methods included hanging, jumping from heights, and railway suicides, followed by intoxication and firearms. In the United States, among children who committed suicide, ~~strangulation/~~suffocation was the most frequent method, followed by firearm use.

While suicidal poisoning is a common method in Sri Lanka for adolescents and adults, its incidence has decreased due to stricter pesticide regulations and public awareness compared to previous years[9]. Globally, poisoning accounts for 7% of accidental injuries in children under five. Child mortality from poisoning is around 2% in developed countries but is higher, exceeding 5%, in developing countries.

Recent studies by the American Academy of Child and Adolescent Psychiatry (2024) and other academic sources have revealed that the use of drugs and alcohol can contribute to the occurrence of any type or circumstance of unnatural death[10]. Addiction to narcotic drugs is also a contributing factor to UD among children.

Causes of death of children in Asia and Southeast Asia have not been researched separately and remain an avenue for future research. This may differ from global statistics, highlighting the need for economic policies that promote health equity and reduce premature deaths.

LIMITATIONS AND STRENGTHS

The autopsies were mostly negative for alcohol, and other toxicology data were incomplete. The study context, being urban Sri Lanka, may limit its application to rural areas due to differing socioeconomic and cultural contexts. Future research with more comprehensive data and broader representation is needed.

CONCLUSION

Unnatural deaths are avoidable and preventable in comparison with natural deaths. To effectively prevent these unnatural deaths, accurate data collection through medico-legal investigations is essential. Conducting public awareness campaigns, educating caretakers on safety precautions, and advocating for mental health and safety legislation can be addressed with this data. Authorities should utilise these distributions to identify children at risk and take necessary actions.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The author declared no conflicts of interest.

DISCLOSURE

ANV and KASK are members of the Editorial Board of the Sri Lanka Journal of Forensic Medicine, Science & Law. Therefore, they did not participate in any way in the publication/decision-making process of this submission, as per journal policy.

ETHICAL ISSUES

This ethical approval for this study was obtained from the Ethics Review Committee, Faculty of Medicine, University of Peradeniya (Ref. No. 2021/EC/49).

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

SS: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **ANV:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **KASK:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **EMNKE:** Analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):19-22
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8022

CASE REPORT

A FATAL CASE OF SADDLE PULMONARY EMBOLISM: IS IT DUE TO HUMP-NOSED VIPER ENVENOMATION?

Wijenayaka PRC*, Ruwanpura PR
Office of the Judicial Medical Officer, National Hospital, Galle, Sri Lanka

ABSTRACT

Hump-nosed viper (HNV) bites are a common occurrence in Sri Lanka, and systemic envenomation followed by acute renal failure (ARF) and Micro Angiopathic Haemorrhagic Anaemia (MAHA) are well-documented complications. But pulmonary thromboembolism has never been reported. A 56-year-old previously healthy gentleman presented following an HNV bite with the complaint of pain at the site. On examination, fang marks were observed over the left 4th toe with local reaction. His initial clotting profile was unremarkable, but he got deranged on the third day, complicated with low urine output. While he was on peritoneal dialysis on the 9th day, he suddenly developed shortness of breath and expired. The autopsy revealed local necrosis over the bite site, indwelling saddle pulmonary thrombus and bilateral deep vein thrombosis. There was macroscopic and microscopic evidence of ARF. The histology of the lungs was suggestive of pulmonary hypertension. Effects of HNV bites range from local features to systemic envenomation like venom induced coagulopathy, thrombotic microangiopathy and ARF. Venom contains mild procoagulant and phospholipase activity, giving rise to MAHA. But deep vein thrombosis followed by pulmonary embolism (PE) has never been reported for HNV bites. The etiology of PE could be due to the shared effects of undiagnosed pulmonary hypertension, prolonged bed rest and venom induced coagulopathy. Systemic envenomation is not uncommon with HNV bites complicated with ARF and MAHA. Since PE has not been documented earlier as a complication, it is suggested that the possible association with future research, though there were a few other risk factors involved.

Keywords: *Hump nosed viper bites; saddle pulmonary embolism; systemic envenomation*

Corresponding author: Wijenayaka PRC
roshelclaude@gmail.com
https://orcid.org/0000-0003-2071-8362

ARTICLE HISTORY
Received: 29.12.2024
Received in revised form:31.12.2024
Accepted: 27.01.2025
Available online: 30.05.2025

INTRODUCTION

Hump-nosed viper (HNV) or *Hypnale hypnale* bites are common in Sri Lanka, especially in rural areas throughout Sri Lanka. It has been found that the venom of the hump-nosed viper contains procoagulant enzymes and phospholipases, which can give rise to a variety of systemic effects such as venom-induced coagulopathy, acute renal failure (ARF), and microangiopathic haemorrhagic anaemia (MAHA)[1]. These three complications are commonly observed following envenomation and are well-documented in clinical literature. However, pulmonary thromboembolism (PE), especially saddle pulmonary embolism, has never been reported with HNV bites.

Pulmonary embolism occurs when the pulmonary arteries are occluded by an indwelling blood clot, leading to respiratory and cardiovascular collapse. It is often related to risk factors such as prolonged immobility, venous stasis, hypercoagulable states, trauma, etc.[2]. Here we present a potential novel complication, saddle pulmonary embolism, in a case of HNV envenomation that has not been reported previously.

CASE HISTORY

A 56-year-old, previously healthy man with no significant medical history presented with a hump-nosed viper bite on the left foot. He complained of pain at the site of the bite, and on examination, fang marks and local erythema were observed. The initial clotting profile revealed no significant abnormalities, and there were no signs of systemic envenomation. However, by day three, the patient's clotting profile got deranged, with prolonged prothrombin time (PT) and activated partial thromboplastin time (aPTT), suggestive of venom-induced coagulopathy[3].

In addition to coagulopathy, the patient developed oliguria, leading to the diagnosis of acute renal failure (ARF). Peritoneal dialysis was initiated on day seven of admission. By the ninth day, the patient suddenly developed shortness of breath and respiratory distress. Despite intensive efforts to resuscitate, the patient unfortunately expired. An autopsy was performed, and it revealed several concerning findings. Local necrosis at the bite site (Fig. 1) was noted, and an indwelling saddle pulmonary embolism (Fig. 2) was observed, obstructing the pulmonary arteries. Bilateral deep vein thrombosis (DVT) was present in the lower extremities (Fig. 3). Histological examination of the lungs revealed evidence of pulmonary hypertension (Fig. 4), while the kidneys showed changes consistent with ARF.

Figure 1: Local necrosis over the bite site on the left foot (white arrow)

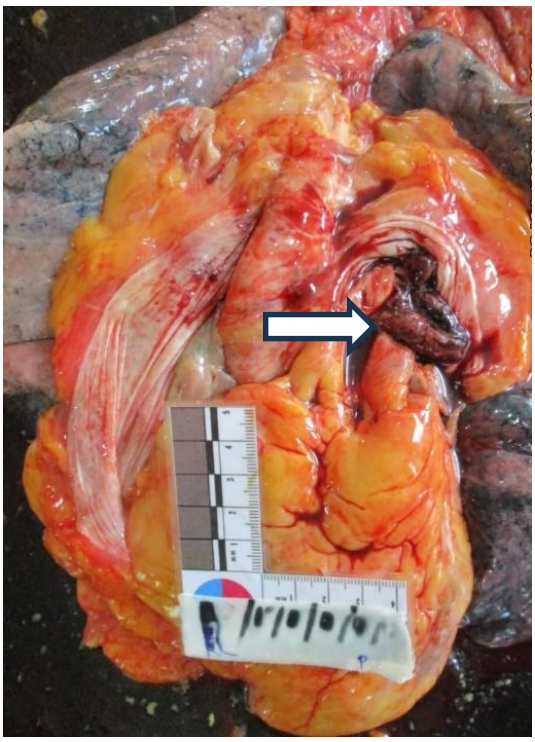

Figure 2: Indwelling saddle pulmonary thrombus obstructing pulmonary arteries (white arrow)

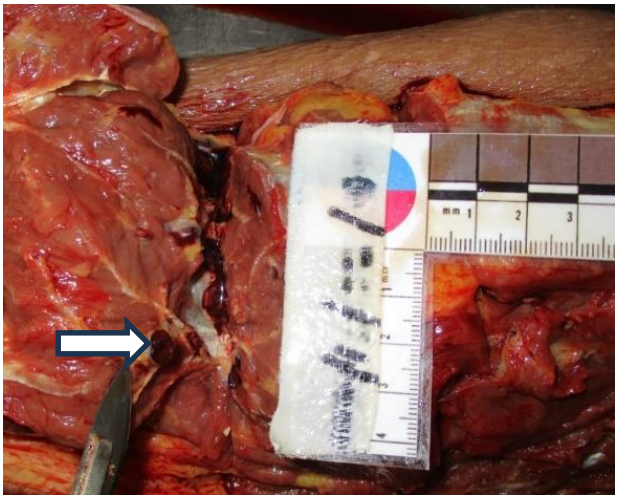

Figure 3: Deep vein thrombosis over one of the lower limbs (white arrow)

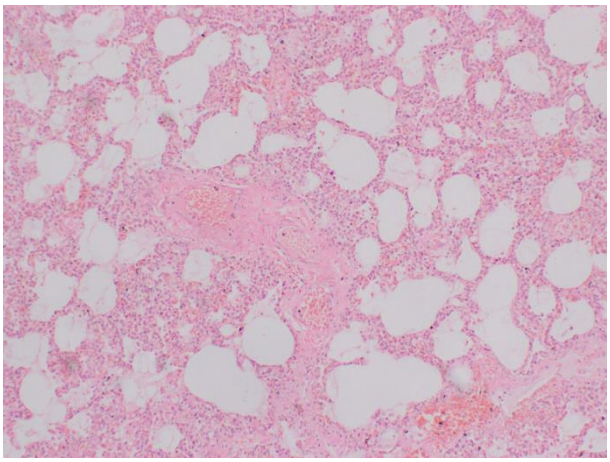

Figure 4: Photomicrograph of lung tissue showing vascular remodelling (H&E ×10)

DISCUSSION

ARF, MAHA, and venom-induced coagulopathy are well documented complications of the systemic effects of HNV bites. These complications are related to the venom's procoagulant properties, which cause widespread microvascular injury, thrombosis, and hemolysis[4]. However, the occurrence of pulmonary thromboembolism, especially saddle pulmonary embolism, has not been reported in the literature.

The development of PE in this patient can be attributed to a combination of factors. First, venom-induced coagulopathy may have contributed to the formation of microthrombi, particularly in the deep veins. The prolonged bed rest necessitated by peritoneal dialysis for ARF likely promoted venous stasis, further increasing the risk of thrombosis[5]. Additionally, histological evidence of pulmonary hypertension may have predisposed to the development of PE due to turbulent flow within and endothelial damage[6]. The presence of bilateral deep vein thrombosis (DVT) and saddle pulmonary embolism suggests that the clot formation in the lower extremities eventually migrated to the pulmonary arteries, blocking blood flow and resulting in fatal respiratory and cardiovascular collapse.

Moreover, the possibility of undiagnosed underlying clotting disorders cannot be excluded in the development of thromboembolic complications. The patient may have had a pre-existing clotting disorder, such as a mild deficiency in natural anticoagulants (e.g., Protein C or S deficiency), which could have predisposed him to thrombosis when combined with the procoagulant effects of the snake venom[7].

Another contributing factor could be the impact of renal failure on coagulation. ARF often results in altered haemostasis due to changes in platelet function, clotting factor levels, and the accumulation of waste products that interfere with coagulation. The patient's renal impairment could have exacerbated the effects of venom-induced coagulopathy, leading to a greater predisposition for thrombus formation. In addition, dialysis itself may have influenced coagulation by altering levels of various coagulation factors like tissue factor and fibrinogen[8].

CONCLUSION

This case represents the first documented case of saddle pulmonary embolism in a patient with hump-nosed viper envenomation. While systemic envenomation with complications such as acute renal failure and microangiopathic haemorrhagic anaemia is well recognised, the development of pulmonary embolism in this patient suggests the need for further research into this potential complication. The causes of pulmonary

embolism may include a combination of a multitude of factors such as venom-induced coagulopathy, prolonged immobility due to ARF and dialysis, undiagnosed clotting disorders, renal failure impacting coagulation, etc.

The authors recommend that clinicians remain vigilant for thromboembolic complications, including pulmonary embolism, in patients with systemic envenomation, particularly in those with prolonged bed rest or other risk factors. Further studies are recommended to better understand the pathophysiology of thromboembolic events in snakebite envenomation, which may be helpful in the development of preventive strategies and improved management for such patients.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The presented case was conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines without divulging the identity of the individual.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

PRCW: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **PRR:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):23-25
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8031

CASE REPORT

AN UNINTENDED ASPHYXIATION OF A PARA-SUICIDE: FORENSIC CHALLENGES IN DETERMINING THE CIRCUMSTANCES

Lowe WMT[1]*, Hulathduwa SR[1], Dassanayake PB[2]
[1]*Department of Forensic Medicine, Faculty of Medical Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*
[2]*Office of the Judicial Medical Officer, Colombo South Teaching Hospital, Kalubowila, Sri Lanka*

ABSTRACT

Hanging is a common method of suicide in Sri Lanka, conventionally considered a mode of asphyxia. Partial hanging, where the entire weight of the body is not applied for the constriction of the neck due to the use of a separate rope tied around the waist for controlling the force, is a complex circumstance leading to a query regarding the intention of the individual. A 41-year-old male with a history of four previous suicidal attempts by hanging was found dead in a partial hanging in his bedroom. The body was discovered within 15 minutes after the incident in a seated position, with his neck stretched with a saline tube fixed to a rafter. There was also a nylon rope attached to his waist and to the point of suspension so that he could control the force applied around the neck by clinging on to this guy-rope. He has, on four previous occasions, done the same thing to frighten his wife. The scene examination revealed a body in a partial hanging remaining in the seated position. The family members have cut the saline tube, taking this for yet another impulsive suicidal attempt. Otherwise, the scene was undisturbed. Postmortem examination did not reveal any injuries to neck muscles, skeletal and vascular structures of the neck, except for the faint ligature mark. The rest of the body was devoid of injuries and prominent cardinal features of asphyxia. The deceased had seemingly attempted to modify the constricting force around the neck by controlling the bodyweight with a second rope. Though these types of applications are recorded in sexual asphyxias, it is virtually unheard of in suicidal hanging. In the context of his previous para-suicidal attempts, it is a challenge for the pathologist to decide whether the circumstances as accidental or suicidal. This warrants the need for a 'psychological autopsy' in such ambiguous cases.

Keywords: *Para-suicide, psychological autopsy, sexual asphyxia*

Corresponding author: Lowe WMT
lowe.mahesh@gmail.com
https://orcid.org/0009-0004-2035-9704

ARTICLE HISTORY
Received: 31.12.2024
Received in revised form: 11.02.2025
Accepted: 21.02.2025
Available online: 30.05.2025

INTRODUCTION

Para suicidal attempt implies a less lethal suicide attempt, also known as a suicidal gesture, is a deliberate act of self-harm that is not intended to result in death[1]. The intent may not be to die, but these attempts can still have serious consequences, including injury or even accidental death[1]. It often serves as a way to communicate distress rather than a genuine attempt at suicide[2]. Hanging is a common method of suicide in Sri Lanka. Differentiation of the circumstances of such parasuicidal attempts leading to death will be a major concern for the judicial medical officer.

CASE HISTORY

A 41-year-old male manual labourer with a documented history of chronic alcohol abuse and recurrent domestic violence incidents, including recent legal charges for spousal battery, presented with fatal suicidal hanging. He had multiple prior suicide attempts by hanging, according to collateral history from family and community members. On the day of the incident, he had locked himself up inside the house following an altercation with his wife. Upon forced entry by his family members 30 minutes later, they discovered the deceased partially sitting in front of their cupboard, suspended with a saline tube around the neck and connected to the roof (Fig. 1 and 2). The scene investigation did not reveal any signs of violence or disturbance to the scene, other than the efforts to rescue him by cutting the saline tube. According to eyewitnesses, the door was blocked from the inside by a chair. His clothes were not disturbed, and there were no visible injuries or blood marks on the body or in the room. The windows were closed, and they had fixed grills. The other end of the saline tube was tied to the roof, and it was cut, and there was a nylon rope tied to the same bar 30 cm from the saline tube (Fig. 3). The nylon rope was torn and broken. According to the eyewitness, the saline tube was not wrapped around the neck; only a single loop was found on the anterior neck.

Figure 1: Body of the deceased found at the scene

Figure 2: Diagram of the hanging

Figure 3: The point of suspension with the two ropes attached

The autopsy revealed an average-built male clad in a sarong with a brown-coloured belt. A nylon rope was tied to the belt (Fig. 4). There were no external injuries other than a skin contusion on the left side of the neck. There were no defence injuries or any other injuries. No petechial hemorrhages at the eyes. No facial congestion, perioral/dental injuries, or petechial haemorrhages were observed. A faint ligature mark was noted 19 cm in size, 0.6 cm in width, and 8 cm below the chin, extending backward and upward in an inverted 'V' shape. There were no underlying skeletal or muscle injuries. The lungs were heavy with moderately significant pulmonary odema. Partially digested

food was present in the stomach with an added aromatic odour of liquor. The musculoskeletal dissection did not reveal any deep muscle or skeletal injuries. Blood samples were sent to the government analyst for toxicological analysis, including quantification of serum alcohol levels.

Figure 4: Nylon rope that was attached to the belt

During the reconstruction of events, it was hypothesised that he may have tied the nylon rope around his belt after climbing on top of the cupboard and then tied both the saline tube and nylon rope to the roof bar. He may have tried to control his weight during hanging by using the nylon rope (Figure 02), but unfortunately, it has broken. This may have tightened the saline tube around the front of the neck. He may have been incapacitated/intoxicated due to alcohol consumption. The postmortem did not reveal any features suggestive of foul play. There were no suicidal notes, indicating it may not have been a planned act. Finally, it was concluded that death was due to unintended asphyxiation from hanging following a parasuicidal attempt.

CONCLUSION

The differentiation of parasuicidal attempts leading to death, homicide, accidental hanging, and sexual asphyxia is a major concern. Details from eyewitness statements, scene visits, circumstance analysis, postmortem examination, and event reconstruction play a major role in a similar scenario. It is a challenge for the forensic pathologist to decide whether the circumstance was accidental or suicidal, warranting the need for a 'psychological autopsy' in such ambiguous cases.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The presented case was conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individual.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

WMTL: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **SRH:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **PBD:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):26-30
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8016

CASE REPORT

A RARE CASE OF ELECTROCUTION DUE TO DIRECT CURRENT (DC) GENERATED BY A SOLAR PANEL: A CASE REPORT

Karunatilake CD*, Alagiyawanna AMATRK, Rajaguru CK
Office of Judicial Medical Officer, Colombo North Teaching Hospital, Ragama, Sri Lanka

ABSTRACT

Electric hazards in the workplace are common in developing countries, where most of them are caused by alternating current. Here we present a rare case of high-voltage direct current electrocution in a solar panel worker. The severity of electric injuries depends on multiple factors. Alternating current is four to six times more likely to cause death than direct current. However, high-voltage direct current could result in a fatal outcome occasionally. Therefore, it's important to know the differences in pathophysiological impacts between alternative and direct current. A solar panel worker in an industrial setting accidentally shocked himself while wearing only shoes as protective equipment and was pronounced dead at the scene. Postmortem examination disclosed torn-off garments, typical joule-burns, singeing of hair, arc-burns and other burns of multiple degrees. Internal examination revealed organ congestion, whereas histological examination revealed elongation of cells of the lower layers of the burnt epidermis. The urine multi-drug screening test was negative, and no further toxicological analysis was performed. The cause of death due to electrocution was made based on the circumstances, scene visit findings, postmortem examination, histological examination and toxicological analysis. High-voltage and high-amperage electricity is deadly from either alternating or direct current. Where there is a massive expansion in the solar power field, it's necessary to have protective measures to prevent such untimely deaths.

Keywords: *Direct current; electric injury; solar power*

Corresponding author: Karunatilake CD
drkarunatilake@gmail.com
ORCID iD: https://orcid.org/0009-0007-1287-3182

ARTICLE HISTORY
Received: 24.12.2024
Received in revised form: 21.02.2025
Accepted: 22.02.2025
Available online: 30.05.2025

INTRODUCTION

Workplace electricity accidents are a common occupational hazard in developing countries like Sri Lanka, owing to improper occupational training and lack of safety measures[1]. Electrocution by direct current (DC) cases are scarcely reported in the local setup. In contrast to alternating current (AC), DC causes less harm at similar voltages. For DC to produce a significant bodily injury, it should be a high-voltage direct current (HVDC) electrocution. According to the Federal Statistical Office of Germany, between 2006 and 2015, electrical injuries by DC stood at 5.1%–8.15% out of all

electrical injuries. There are only a few reported cases of death by DC worldwide[2].

We present a case of electrocution by DC, where a “solar panel worker” got electrocuted while attaching a series of solar panels in an industrial setting. He lacked proper training, and no personal safety measures were employed. A postmortem examination was performed, which revealed classic features of electrocution with extensive burn injuries.

CASE HISTORY

A 19-year-old male solar panel worker accidentally electrocuted himself while connecting a series of solar panels in an industrial setting without proper protective equipment. Co-workers heard an explosion and found a “junction box” of a solar panel on fire (Fig. 1) and a shattered solar panel, with the worker lying supine in the vicinity.

Figure 1: Junction box of the shattered solar panel that was ignited.

He was pronounced dead at the scene, and the body was brought to the mortuary for postmortem examination. Torn-off garments were seen over the right arm, right side back of the chest, and right gluteal area. A typical "Joule burn" with a collapsed blister was seen over the right palm with a clenched fist, which was the entry point (Fig. 2). Second-degree burns were seen involving the right distal forearm and right arm up to the axilla (Fig. 3). Axillary hair was partly singed. The "crocodile-skin" appearance due to arc burn was seen over the right mid-forearm up to the elbow joint (Fig. 4).

Figure 2: Joule burns of the right palm shown by arrows (white), corresponding with the entry point of the current.

Figure 3: Burns of the right arm extending up to the axillary region.

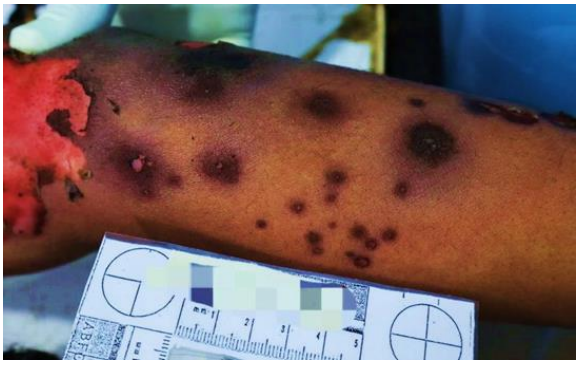

Figure 4: Arc burns on the right forearm produced by arcing of the current, giving rise to the “crocodile skin” appearance.

A third-degree burn was seen over the left gluteal region, underneath the burnt and torn clothing. Internal examination revealed slight congestion of the brain. Petechial haemorrhages were seen on the visceral pleura and epicardium. Musculoskeletal dissection did not reveal any soft tissue injuries or fractures. A urine multi-drug screening test was performed and was negative for common substances of abuse. No further toxicological analysis was done.

Histological examination of the heart did not reveal any abnormalities. Skin sections from the area of burns showed elongation of cells of the lower layers of the epidermis with micro-blister formation. A conclusion of "death by electrocution" was made, taking into consideration the scene and postmortem findings, toxicological analysis, and histological examination.

DISCUSSION

The severity of electric injuries mainly depends on the voltage and amperage of the current, type of current (AC/DC), resistance provided, duration of contact, pathway of the current through the body, and environmental factors[2].
Alternative current (AC) is four to six times more likely to cause death than direct current (DC), partly due to its "hold-on" effect and increased ability to cause cardiac dysrhythmias[3].

Physiological impacts of AC and DC currents are different[6]

•Threshold of perception: AC: 0.5 mA, DC: 2 mA
•Let-go threshold: AC: 10 mA, DC: 75 mA (In a 70 kg adult)
•Threshold for ventricular fibrillation: AC: 40 mA, DC: 140 mA
• Life-threatening voltage: AC: 50 V, DC: 120 V

Photovoltaic electricity produces 0.6 V through a single cell at 25°C. The average amperage produced by solar panels is 10A, whereas the voltage of a single panel stands at 40V–50V[4]. Multiple solar panels are connected in series to increase the voltage (average domestic circuit: 600V-1000V, average industrial circuit: 1kV-10kV)[4].

As long as solar panels are exposed to light, they produce potentially lethal amounts of DC electricity *(DC danger zone)*[4]. In this case, more than 10 panels had been connected in series, generating a current of 10A-13A and a voltage of 500V–1000V. The high amount of DC traveling in a one-way direction creates a strong contraction when it contacts the body, making it difficult to break free[4]. Any attempt to break the load from the source may result in the current arcing and causing a spark lesion. Multiple spark lesions give rise to a "crocodile skin" appearance. At 1000V, the current will jump a few millimetres, and at 100kV, about 35cm, producing a very high temperature (4000°C)[4,9].

Most deaths occur due to cardiac arrhythmia (ventricular fibrillation) as a result of the current passing through the heart. The pathway of the current will depend on the relative resistance of potential exit points and tends to take the shortest route between entry and exit points[9]. Since this worker had worn protective shoes, the current was thought to have entered through the right hand and exited through the left buttock.

A less common mode of death is where the diaphragm and intercostal muscles get paralysed due to the current passing through the thorax. These deaths occur due to cessation of respiration, leading to hypoxia, where signs of congestive heart failure can be found[9]. Rarely can the current enter through the brain, paralysing the brainstem and ultimately leading to cardiorespiratory arrest. In this case, there is a high probability of cardiac arrhythmia being the mode of death[9].

Non-electrical trauma also accounts for a considerable number of electricity-associated injuries. Falling from heights or being flung over after being electrocuted can result in fractures and other life-threatening injuries.

Regarding cutaneous electric marks, there may be instances where no skin lesions are found at

the entry and exit points. Therefore, it is important to obtain a detailed history regarding the incident, do a proper scene visit, and conduct a thorough postmortem examination, including toxicological and histological analysis, before confirming death by electrocution. Deaths due to electrocution can occur without any external or internal signs, highlighting the importance of excluding other possible causes of death.

This 19-year-old worker was employed without proper training or standard protective gear such as hard hats, safety gloves, safety glasses, and arc-flash clothing. This emphasises lapses in standards and legislation of the solar industry in Sri Lanka, which may be in part due to its rapid growth and high demand[5,7]. Finally, compensation for the next of kin of the deceased through workmen's compensation is a matter to be addressed.

CONCLUSION

High-voltage and high-amperage electricity is deadly, whether from an AC or DC source. Accidental electrocution is an expected occupational hazard for solar panel workers. With the rapid growth of the solar panel industry in Sri Lanka, it is important to update workers to prevent such accidents and untimely deaths. Thus, guidelines and hazard prevention training for the solar panel industry are a need of the hour.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The author declared no conflicts of interest.

ETHICAL ISSUES

The presented case was conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines without divulging the identity of the individual.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

CDK: Conception or design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published. **AMATRKA:** Conception or design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published. **CKR:** Conception or design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):31-33
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8029

CASE REPORT

ERECTILE DYSFUNCTION AS A DEFENCE IN SEXUAL ABUSE: HIGHLIGHTING MEDICO-LEGAL ISSUES IN A CASE REVIEW

Attygalle U, Premaratne CN*
Office of the Judicial Medical Officer, Teaching Hospital, Ratnapura, Sri Lanka

ABSTRACT

Erectile dysfunction (ED) is a complex condition that has significant medico-legal implications, particularly when presented as a defence in cases of sexual abuse. This report discusses a case involving a 52-year-old male labourer accused of sexually abusing his 12-year-old daughter in 2019. The examinee claimed that burn injuries sustained in 2008, following a seizure, resulted in ED, rendering him incapable of committing the alleged act. Examination revealed scarring on the anterior chest, abdomen, thighs, and genital region, although the penile tissue was minimally affected. Multidisciplinary assessments, including a papaverine test, urological, neurological, and psychiatric evaluations, were inconclusive in confirming or refuting the claims. The findings underscore the challenges in correlating ED to allegations of sexual incapacity during the specific period. This case highlights the complexities of evaluating ED in a legal context, emphasizing the interplay of organic and inorganic factors. It underscores the need for comprehensive clinical and investigative evaluations to aid in the diagnosis or exclusion of ED, which contributes to arriving at medico-legal conclusions in such contexts.

Keywords: *Erectile dysfunction; sexual abuse; papaverine*

Corresponding author: Premaratne CN
chathz_np@yahoo.com
https://orcid.org/0009-0004-8801-119X

ARTICLE HISTORY
Received: 31.12.2024
Received in revised form: 13.03.2025
Accepted: 14.03.2025
Available online: 30.05.2025

INTRODUCTION

Erectile Dysfunction (ED) is a common complaint among men over 40 years of age, and the prevalence increases with age[1]. The Massachusetts male ageing study, conducted from 1987 to 1989 in men aged 40 to 70 years, concluded that impotence is strongly associated with age, has multiple determinants, including some risk factors for vascular disease, and may be due partly to modifiable para-ageing phenomena[2]. In the medico-legal setting, ED can be presented as a defence in sexual offence cases, where the accused claims an inability to perform sexual intercourse. Such cases pose significant challenges for medico-legal practitioners, as ED has a multifactorial aetiology that can include physical factors such as chronic illnesses, psychological factors such as anxiety and depression, lifestyle factors such as alcohol and/or substance use and other situational factors such as stress/pressure from the alleged abuse in this case, relationship problems, being in an uncomfortable/ unfamiliar setting and cultural/social stigma[3,4]. Proper evaluation of these claims requires a multidisciplinary approach and careful correlation of clinical findings with the timeline of an alleged event. This report elaborates on medico-legal evaluation to address the credibility of the ED as a defence in sexual abuse.

CASE HISTORY

A 52-year-old married male, who works as a labourer, was accused of sexually abusing his 12-year-old daughter in 2019 and was produced to the Office of the Judicial Medical Officer at Teaching Hospital Ratnapura, through the High Court Ratnapura in August 2023. The examinee reported having a history of seizures without documented evidence. He stated that in 2008, following a seizure episode, he fell onto a fire pit, sustaining burns over the anterior chest, abdomen, thighs, and genital area. He claimed these injuries caused permanent inability to perform sexual intercourse and also resulted in a complete loss of interest in sexual activity.

General examination revealed an averagely built and moderately nourished adult male, who was conscious and rational. He was oriented in place, time and person. There was no sub-normality in his general physical status. Basic systemic examinations were unremarkable. Irregularly shaped scars over the anterior chest and abdomen, with areas of wrinkling and hyperpigmentation interspersed with hypopigmented patches and absent body hair. The scars occupied a body surface area (BSA) of 8.5%. The scars over the chest displaced both the nipples downwards. The anterior aspect of both thighs and the pubic area also showed similar scarring with absent hair growth in affected regions, involving a BSA of 8%. These scars were consistent with deep partial-thickness burns. The scars in the genital region were limited to the anterior scrotum and base of the penis, with less than 5mm linear extensions to the penile shaft. No deformities or significant abnormalities were noted in the shaft of the penis. The rest of the genital examination including the glans penis, prepuce, external urethral meatus, frenulum, both testes, epididymis and spermatic cords was unremarkable. Other than the scars described above, there were no other scars indicative of an accidental fall on the body of the examinee.
Despite these findings, the lack of documented evidence of seizures or burn injuries complicated the case further. No corroborative medical records were available to validate the examinee's claims of sustained injuries and their subsequent impact on sexual function.
Referral to the consultant physician yielded unremarkable results. Neurological evaluations indicated no signs of neurogenic ED, while psychiatric assessment suggested the possibility of psychological stress contributing to sexual dysfunction. A papaverine test conducted by the consultant urological surgeon, which failed to produce an erection, raised questions about potential physiological or psychological causes.

DISCUSSION

The papaverine test, while useful, has limitations due to potential false negatives or underlying vascular conditions. It is important to first understand the significance of a positive test versus a negative one. In the past, a positive papaverine test was presumed to indicate normal erectile hemodynamics. However, recent studies have revealed a positive test even in patients suffering from penile arterial insufficiency. Therefore, a positive intracavernous papaverine test may indicate veno-occlusive dysfunction, but does not necessarily signify a normal penile arterial system[5]. On the other hand, a negative test indicates a variety of underlying causes, including vascular pathologies, which might be otherwise excluded with a positive test, that need to be evaluated. It is also important to be mindful of the possibility of false negatives caused by improper technique, psychological stress, variations in individual metabolism, pain and scar tissue formation among other factors.
The papaverine test on its own is also not considered the gold standard in diagnosing ED. The Combined Intracavernous Injection and Stimulation (CIS) test is the most accepted test for evaluating and diagnosing erectile dysfunction. It should be combined with colour Doppler ultrasonography to determine the vascular component of ED, as it is otherwise not possible to differentiate between slight penile arterial insufficiency and neurogenic or psychogenic ED with the CIS test alone[5].

Considering the fact that the examinee was produced for medico-legal examination in 2023, it is very difficult to make a diagnosis of ED retrospectively. Therefore, it is not possible to

comment on his ability to have performed sexual intercourse during the period of the alleged sexual abuse in 2019, Delayed examination, lack of evidence that the burns were caused before the alleged incident of sexual abuse, and unreliability of the intracavernous papaverine injection alone are factors affecting the conclusions of this case. Therefore, the medico-legal opinion following clinical forensic examination is that his claim of having had ED since the accidental fall cannot be confirmed or excluded at the time of examination. If ED is confirmed in a sex offender, then the treatment of such a person poses legal and ethical dilemmas that the current Sri Lankan framework is not yet equipped to handle[6].

CONCLUSION

This case underscores the challenges in using ED as a defence in sexual abuse allegations. A multidisciplinary approach is essential for thorough and objective medico-legal assessment, including awareness and implementation of the currently accepted gold standard testing of CIS and Color Doppler ultrasonography to diagnose ED.

ACKNOWLEDGMENTS

The authors acknowledge the support extended by Dr. Nishantha Weerasinghe (Consultant Urological Surgeon), Dr. K. Jeganathan (Specialist in Internal Medicine), Dr. Champika Gunawardhana (Consultant Neurologist), Dr. Surath Munasinghe (Consultant Neurosurgeon), and Dr. Indu Maheshika (Acting Consultant Psychiatrist) of the Teaching Hospital, Ratnapura, in preparing this manuscript.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The presented case was conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individual.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

UA: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **CNP:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):34-37
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8023

CASE REPORT

HINGE SKULL FRACTURES IN PEDESTRIANS: REVIEW WITH THREE FATALITIES

Wijayarathne JAPT*, Paranitharan P
Department of Forensic Medicine, Faculty of Medicine, University of Kelaniya, Sri Lanka

ABSTRACT

Hinge fractures typically occur as a result of direct force to the chin, lateral head impacts, or side-to-side compression and are frequently associated with high-velocity collisions involving motorcyclists, commonly referred to as "motorcyclist fractures." This report discusses three cases of hinge fractures identified during the autopsies of pedestrians. In all three cases, the autopsies revealed a hinge fracture extending obliquely through the middle cranial fossa from one lateral side to the other, with no evidence of injuries to the chin. Analyzing the mechanisms underlying these fractures provides valuable insights into the circumstances of the incidents and aids in reconstructing the events leading to the injuries.

Keywords: *Autopsy; pedestrian; road traffic collisions*

Corresponding author: Wijayarathne JAPT
pabasarawijayarathne@gmail.com
https://orcid.org/0009-0006-2199-4739

ARTICLE HISTORY
Received: 30.12.2024
Received in revised form: 16.02.2025
Accepted: 26.02.2025
Available online: 30.05.2025

INTRODUCTION

A hinge fracture (HF) is a specific type of skull base fracture characterised by a transverse fracture line, commonly across the middle cranial fossa, involving the temporal and sphenoid bones. The fracture line traverses the pituitary fossa, following the path of least structural resistance. The term "hinge" describes the movement of the separated skull segments, which resembles the motion of a hinge.

In general, skull base fractures are relatively uncommon, occurring only in approximately 4% of all patients with severe head injuries[1]. These fractures are frequently associated with motorcyclists involved in high-velocity collisions. One study revealed that, among victims of motor traffic accidents, only 15% of motorcyclists did not sustain skull base fractures[2]. HF, a unique type of skull base fracture, is often referred to as the "motorcyclist fracture" due to its high incidence among motorcyclists.

Although the HF is defined as a transverse fracture of the skull base, the anatomical pathways of the fracture line can vary significantly. However, no definitive single classification is consistently described in the literature. In the commonly used classification, three types of HFs are described as Types I, II, and III[3]. Type I traverses the middle cranial fossa from one petrous ridge to the contralateral petrous ridge, passing through the sella turcica. Type II extends from the front to the contralateral back through the sella turcica, thus involving the anterior, middle, and posterior cranial fossae. Type III follows the suture lines of the frontal and sphenoid bones in the coronal plane without involving the sella

turcica[3]. However, in clinical practice, variations of HFs are encountered that do not fit into any of these categories.

Three different mechanisms have been identified in the causation of HFs. One is side-to-side compression of the skull, as in run-over injuries in road traffic trauma. Here, either side's fracture lines meet at the midline of the skull base. The second mechanism is unilateral force over one temporal bone, in which the force is strong enough to cause a skull base fracture that extends to the contralateral temporal bone. The third mechanism is where force is applied on the mandible (chin), which transmits upward along the mandibular rami or zygomatic arch, entering the skull base through the temporomandibular joint and meeting at the centre. In the latter, there will be evidence to suggest an impact on the chin. The third mechanism has been largely studied using the finite element analysis method and has confirmed the force transmission pathway[4,5].

In common practice, though HFs are considered in motorcycle riders following high-velocity trauma, these fractures can also occur in pedestrians.

CASE HISTORY

Case 01: A 44-year-old female was knocked down by a van from behind, resulting in her hitting her head on the windscreen and then the ground, according to the eyewitness evidence. The autopsy revealed a HF in the middle cranial fossa running obliquely across the sella turcica with additional linear fractures in the anterior and posterior cranial fossae (Fig. 1a)

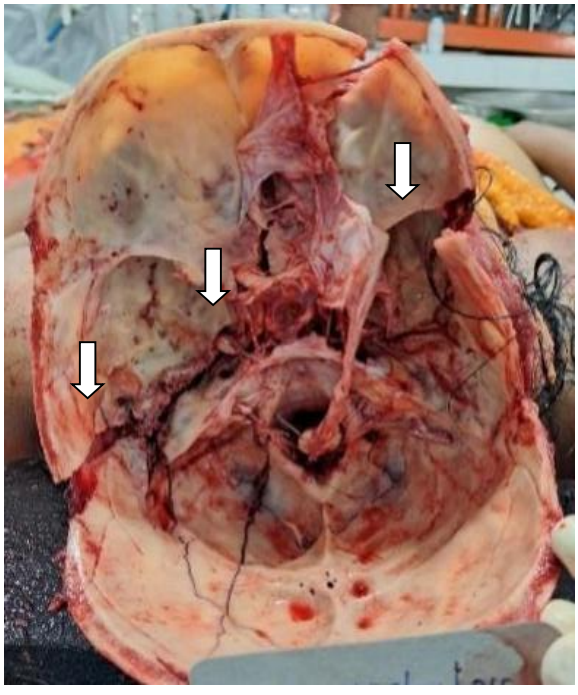
Case 02: A 77-year-old male was hit by a three-wheeler from the front, ejecting him onto the road. CCTV footage was available as circumstantial evidence. The autopsy showed a HF in the middle cranial fossa, which ran obliquely across the sella turcica with a separate linear fracture in the posterior cranial fossa and sagittal suture diastasis. (Fig. 1b)

Case 03: An 80-year-old male was knocked down by a motorcycle. Autopsy findings included a HF in the middle cranial fossa, running obliquely from the right side posterior margin to the left side anterior margin, across the sella turcica, and extending to the left temporal bone of the skull vault (Fig. 1c).

In all three cases, there were no mandibular (chin) injuries or deformation of the head due to side-to-side compression. Lateral impact over the temporal region and mandible, resulting in a transverse fracture of the skull base, is the most plausible mechanism in all three cases. The oblique anatomical pathway of the fracture, rather than a clear transverse line, may provide additional clues regarding the mechanism of injury.

Base of the skull fractures require high-energy impacts. Studies have been conducted to determine the force necessary to cause such fractures, with one study indicating that the artificially induced failure force ranges between 3,000 N and 7,000 N[6].

CASE 1



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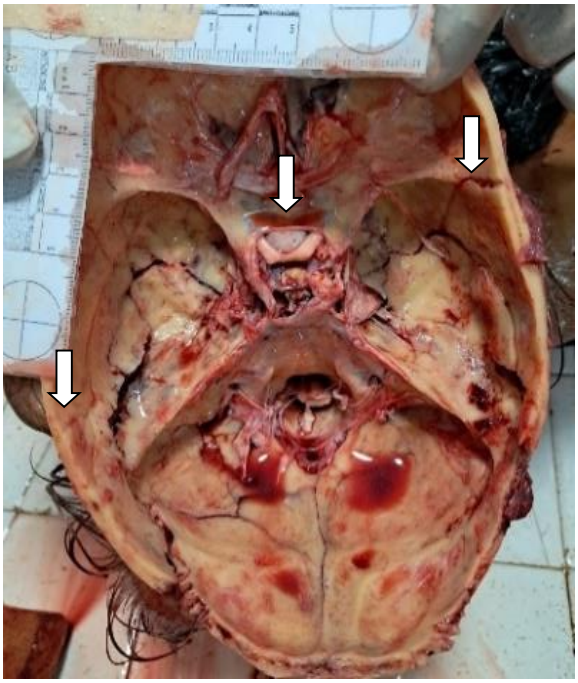

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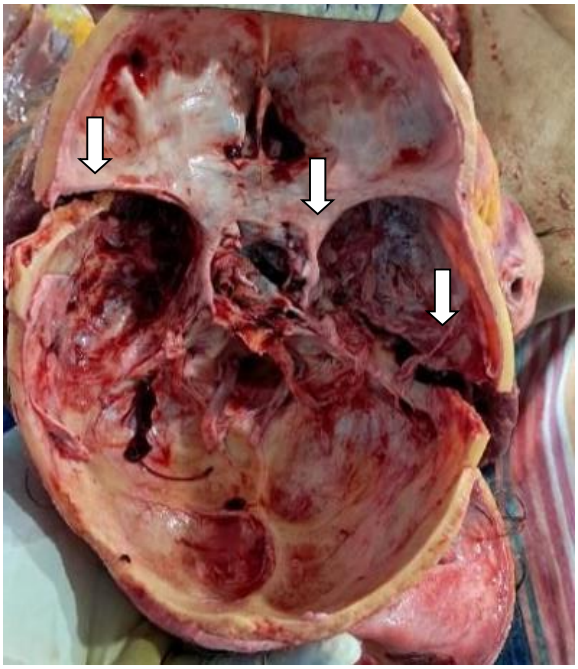

Figure 1: Hinge fractures in each autopsy, running obliquely across the sella turcica, indicated by white arrows

CONCLUSION

Hinge fractures, traditionally associated with motorcyclists and high-velocity trauma, can also occur in pedestrian accidents, as demonstrated by the three cases presented. Understanding these fracture patterns is crucial in forensic and clinical settings, as they can aid in reconstructing the mechanism of injury and distinguishing between different modes of head trauma.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The presented cases were conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individuals.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

JAPTW: Concept designing, acquisition, compiling and analysing of intellectual material, drafting of the manuscript, editing and final agreement of the content to be published. **PP:** Intellectual contribution towards concept, content editing for intellectual input, finalizing the manuscript, and final approval of the version to be published.

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Sri Lanka Journal of Forensic Medicine, Science & Law — May 2025;16(Special Issue):38-41
DOI: https://doi.org/10.4038/sljfmsl.v16i5.8028

CASE REPORT

MENSTRUAL TABOOS AND CHILD RIGHTS: DEATH OF A GIRL DURING MENARCHE

Perera HAVK*, Ruwanpura PR
Office of the Judicial Medical Officer, National Hospital, Galle, Sri Lanka

ABSTRACT

Menarche, the onset of a girl's first menstrual cycle, often introduces menstrual taboos in certain eastern cultures. These taboos may manifest as social isolation, dietary restrictions, and exclusion from religious spaces, which can adversely affect health and promote gender inequality. A 10-year-old girl developed gastroenteritis while in cultural confinement after reaching menarche. Her parents strictly adhered to traditional customs that limited her interactions with the outside world and deprived her of healthy foods. They believed that her fatigue was a result of hormonal changes associated with menarche. Although her condition worsened over four days, they did not seek medical treatment. The child succumbed upon admission. The autopsy revealed extensive cyanosis in the left hand due to multiple thrombotic occlusions of the brachial vein. Microscopic examination confirmed the presence of brachial venous thrombi. The cause of death was determined to be Multiple Organ Dysfunction Syndrome (MODS) as a consequence of hypovolemic shock. Key medico-legal issues in this case include parental negligence and failure to provide medical care under Section 308A of the Penal Code, potentially leading to criminal liability for negligence-related death under Section 298. Violations of the child's rights, protected by the Children and Young Persons Ordinance (CYPO) and the Protection of Children's Rights Act, form the legal framework for child protection in Sri Lanka. The ISD has interviewed family members and collected witness statements from neighbors and teachers, referring the case to the police for further investigation and notifying the National Child Protection Authority for an additional inquiry. Additionally, Sri Lanka is a signatory to the United Nations Convention on the Rights of the Child (UNCRC), which guarantees children's fundamental rights.

Keywords: *Gender inequity; menarche; menstrual taboos*

Corresponding author: Perera HAVK
pvishadha@gmail.com
https://orcid.org/0009-0008-1798-8015

ARTICLE HISTORY
Received: 31.12.2024
Received in revised form: 17.02.2025
Accepted: 03.03.2025
Available online: 30.05.2025

INTRODUCTION

Menarche is the first occurrence of a girl's first period. This should be a natural and empowering experience. Menarche is associated with certain menstrual taboos in certain eastern countries. These taboos may result in social isolation, dietary restrictions, and exclusion from religious places and activities due to the perceived notion of impurity associated with menstruation. Such practices can negatively impact health and result in gender inequality. In some communities, menarche is reckoned as readiness for marriage, which often leads to the risk of adolescent pregnancy with violation of fundamental rights[1,2].

CASE HISTORY

A 10-year-old girl experienced vomiting, watery diarrhoea, and a mild fever suggestive of gastroenteritis while in confinement after her first menstruation. Other family members also exhibited similar symptoms of gastroenteritis. During the time of her first menstrual period, her parents strictly followed traditional customs, limiting her interactions with the outside world, which deprived her of adequate dietary needs. They believed that her fatigue was a result of hormonal changes associated with menarche. Her mother treated her with some over-the-counter medications obtained from a nearby pharmacy without consulting a doctor. Although her condition worsened over the next four days, they did not seek medical treatment, and the child succumbed after admission to the hospital due to severe dehydration.

Upon admission, the clinical notes indicated that she had sunken eyes, dry skin, dry mucous membranes, decreased urine output, and low blood pressure. There was significant cyanosis in the left hand (Fig. 1) caused by multiple thrombotic occlusions in the brachial vessels of the left upper limb (Fig. 2) observed at post-mortem examination.

Figure 1: Cyanosis on the left hand

Figure 2: Multiple thromboses in the brachial vessels (white arrows in a and b)

The brain was pale and oedematous, suggesting hypoxic-ischaemic encephalopathy. The kidneys were swollen and pale, with an indistinct cortico-medullary demarcation. No renal vein thrombosis was observed macroscopically. The liver was enlarged and showed signs of fatty change. The heart was flabby, and all chambers were dilated. The lungs were dark and heavy due to haemorrhagic pulmonary oedema, and both the small and large intestines showed ischaemic changes in the walls, accompanied by necrosis. The spleen was soft and friable.

Histology revealed multiple thrombi within the brachial vessels (Fig. 3). There were features consistent with ischaemic-type acute tubular necrosis of the kidney. Both adrenal glands exhibited small parenchymal haemorrhages, while the lungs showed alveolar haemorrhages

with oedema and varying degrees of neutrophilic infiltration in the interstitium.

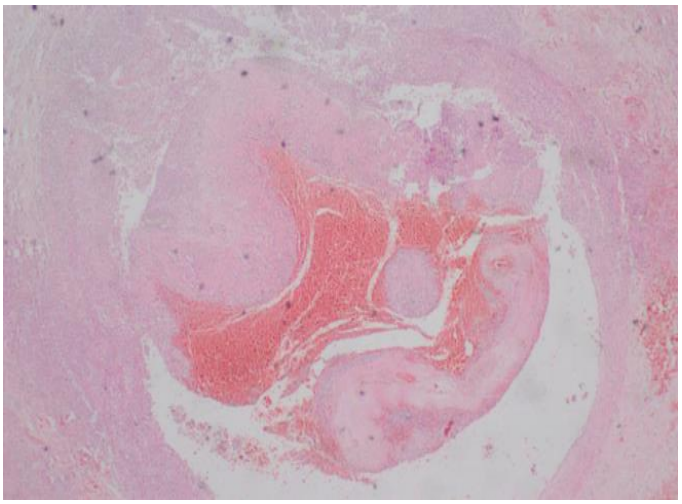

Figure 3: Brachial vessel thrombi (H&E ×10)

The toxicology screening was negative. The postmortem septic screening, including blood, CSF, and urine cultures, as well as viral studies, was negative for common viruses such as influenza, Epstein-Barr virus (EBV), cytomegalovirus (CMV), herpes simplex virus (HSV), and enteroviruses. The cause of death was identified as multi-organ dysfunction syndrome (MODS) resulting from hypovolemic shock.

CONCLUSION

Dehydration is a known independent risk factor for the development of thrombosis. However, there is inadequate evidence to form a strong association between the two. A literature review revealed a few reported cases of deep vein thrombosis (DVT) occurring due to severe dehydration following gastroenteritis[3,4]. When dehydration is associated with immobility, as in this case, deep veins of the upper limb, such as the brachial veins, can develop thrombosis. Dehydration-induced increased blood viscosity, haemoconcentration, endothelial injury, and blood flow stasis collectively contribute to thrombus formation. Traditional Sri Lankan customs about menstruation can negatively impact girls both mentally and physically, as well as in their education. This practice of confining girls during their first period reinforces the idea that menstruation is something to be hidden or feared, fostering a sense of embarrassment rather than acceptance. The main issue in this case is parental ignorance and adherence to traditional practices, which indicates a failure to provide timely medical care to the child. According to section 308A of the penal code of Sri Lanka, such negligence can result in criminal liability, especially if it is found to have contributed to the child's demise. The rights of children are protected by various legal statutes in Sri Lanka, including the Children and Young Persons Ordinance (CYPO) and the Protection of Children's Rights Act[5]. These laws create a framework to safeguard children from harm and promote their welfare. Any violation of these rights not only has legal repercussions but also highlights the responsibility of society to protect vulnerable people. The inquirer into sudden deaths (ISD) and the judicial medical officer (JMO) interviewed family members and referred the case to the police for further investigation. The National Child Protection Authority was notified regarding an additional inquiry. Sri Lanka's commitment as a signatory to the United Nations Convention on the Rights of the Child (UNCRC) reinforces the necessity of adhering to global standards regarding children's rights. The UNCRC guarantees fundamental rights, including access to health care, safety, and proper care, which are particularly relevant in this case.

ACKNOWLEDGMENTS

None.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The presented case was conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individual.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

HAVKP: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. **PRR:** Revising the manuscript critically for important intellectual content; and final approval of the version to be published.

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Saukko P, Knight B. *Knight's forensic pathology*. 4th ed. New York (NY): CRC Press; 2016. P.402.

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Patrias K. Computer - compatible writing and editing. Paper presented at: Interacting with the digital environment. *46th Annual Meeting of the Council of Science Editors*; 2003 May 3-6; Pittsburgh, PA.

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