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PATHOLOGICAL ASPECTS OF MATERNAL MORTALITY: A TERTIARY CARE CENTRE BASED STUDY.

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ABSTRACT
Maternal mortality remains a pressing global issue, with a significant number of deaths attributed to direct causes like haemorrhage and hypertensive disorders. Despite healthcare advancements, achieving the Sustainable Development Goal of reducing maternal mortality to below 70 deaths per 100,000 live births by 2030 is challenging. This study was planned to assess the causes of maternal mortality by gross and microscopic examination of viscera. A total of 60 viscera samples were analyzed and the possible causes were established by co-relating the findings with available clinical history. The majority of mortalities occurred in the age groups of 21-25 years and 26-30 years, each representing 33.3% of the total cases. The number of mortalities found in ANC were 17(28.3%) and that of PNC were 43(71.7%). Direct causes constituted of higher percentage 56.7% (34 cases) than Indirect causes 30% (18 cases), whereas in 8(13.3%) cases cause of mortality could not be established. Postpartum haemorrhage, hypertensive disorders of pregnancy are significant direct causes of maternal mortality.

Key words: Maternal mortality, pregnancy-related deaths, ANC deaths, PNC deaths.

INTRODUCTION
Maternal death is defined by the World Health Organization (WHO) as: the death of a woman in the course of her pregnancy or within 42 days of termination of pregnancy, regardless of the duration or site of the pregnancy, from any cause connected to or aggravated by the pregnancy or its care, but not from accidental or incidental causes(1). 86% of maternal deaths worldwide are due to direct causes; haemorrhage and hypertensive disorders are the most common causes, and deaths due to maternal haemorrhage are significantly more common in developing than in affluent nations (2). Lower incidence of maternal complications resulting in death can be attributed to various factors, including availability of maternal monitoring, antibiotics, and safe health care (3) (4). Each day in 2020, roughly 800 women lost their lives due to preventable factors associated with pregnancy and childbirth, translating to approximately one maternal death every two minutes. The Sustainable Development Goal (SDG) by WHO aims to decrease maternal mortality to below 70 maternal deaths per 100,000

live births by the year 2030 which looks a far-fetched goal at the moment (5). Trends in the maternal mortality ratio (MMR) from 1997 through 2020 studied by Meh C. et al reported that the leading causes of maternal death were obstetric haemorrhage (47%; higher in poorer states), pregnancy-related infection (12%) and hypertensive disorders of pregnancy (7%) (6).

Maternal death can be attributed to various medical factors influenced by sociodemographic, economic, and cultural issues. Immediate deaths often result from life-threatening obstetric complications. Delays in obtaining emergency obstetric care contribute significantly to maternal deaths, including delays in decision-making, travel, and treatment. Adherence to traditional rituals, such as dietary restrictions during pregnancy and reliance on traditional birth attendants, can exacerbate maternal health risks. Unsafe abortion also contributes to maternal mortality due to lack of awareness and access to safe abortion services. Poor health infrastructure and poverty further exacerbate the challenges in accessing timely and quality maternal care. (India. Ministry of Home Affairs. Special bulletin on maternal mortality in India 2004-06: sample registration system. New Delhi: Office of Registrar General, Ministry of Home Affairs, Government of India; 2009.) (7) (8). Maternal mortality can occur across a wide range of ages, but certain age groups are more prone to it than others. Typically, adolescent girls (those aged 15-19 years) and older women (those aged 35 years and above) are considered to be at higher risk of maternal mortality(9).

Maternal autopsy findings offer insights into causes of death. Common findings include haemorrhage signs like uterine rupture, haemorrhagic shock,(10) and hypertensive disorders like eclampsia with cerebral edema (11). HELLP syndrome may show hepatic necrosis, sepsis presents purulent exudates (12) and thromboembolic events manifest as pulmonary embolism (13).Trauma may result in uterine wall disruption, and cardiopulmonary complications such as cardiomegaly or pulmonary edema may occur (14).

MATERIALS AND METHODS

This was a retrospective observational study carried out in the Autopsy section of the department of pathology, Byramjee Jeejeebhoy Government Medical College and Sassoon General Hospitals, Pune, India from March 2022 to February 2023. The hospital, operated by the government of Maharashtra, India, serves the low socioeconomic population of the metropolitan city and surrounding rural areas. Maternal deaths which occurred due to accidental, suicidal or homicidal causes were excluded from the study. Out of 2245 medicolegal autopsies viscera received, total maternal deaths comprised of 60 cases.

Autopsy section of pathology department receives viscera of medicolegal cases chiefly from forensic department of the institution. Medicolegal viscera were also referred for the histopathological examination to pathology department from other government hospitals when there were uncertainties regarding the cause or manner of death, or when clinicians were unable to explain certain findings. Clinical data was retrieved from record section.

Gross and microscopic examination of organs which are commonly received for example. lung, heart, liver, spleen, kidney, cerebrum, cerebellum and uterus were done.

After grossing tissue sections from grossly identified pathological region was processed in tissue processor and Paraffin tissue blocks were prepared. Slides prepared from tissue blocks were stained using hematoxylin and eosin stain, then examined under a microscope. Special stains, such as Ziehl Neelsen stain, periodic acid Schiff, and phosphotungstic acid hematoxylin stains, were performed whenever needed and indicated. The cause of death was determined by considering the available clinical history, gross and microscopic findings, and clinicopathologic correlation.

This study was a Retrospective observational study and data was saved in excel sheets. The data was expressed in terms of percentage and numbers. Simple descriptive statistics such as mean, and median were used for continuous variables. The data was analyzed using IBM SPSS Statistics version 25.

RESULTS

The present study included 60 cases. Among the cases, 21.7% of women were aged 20 years or younger, while the majority fell within the age group of 21-25 years and 26-30 years, each representing 33.3% of the total cases. A smaller proportion of cases were observed in the age group of 31-35 years (8.3%) and those over 35 years (3.3%).

Among the PNC group (n=43), the mean age was 24.4± 4.3 years. In contrast, the ANC group (n=17) had a slightly higher mean age of 27.2± 4.8 years. The p-value associated with the average age difference between the two groups was calculated as 0.033, indicating a statistically significant difference in age distribution.

Table 1: Age distribution of study group between ANC and PNC subgroups

Age distribution of study group					
Age group		PNC (n=43)	ANC (n=17)	Total	P
≤ 20	Number	11	22	13	0.131
	%	25.60%	11.80%	21.70%	
21-25	Number	17	3	20	
	%	39.50%	17.60%	33.30%	
26-30	Number	12	8	20	
	%	27.90%	47.10%	33.30%	
31-35	Number	2	3	5	
	%	4.70%	17.60%	8.30%	
> 35	Number	1	1	2	
	%	2.30%	5.90%	3.30%	

Among individuals aged 21-25, the PNC group had a higher proportion (39.5%) compared to the ANC group (17.6%). Conversely, in the 26-30 age group, the ANC group exhibited a notably larger percentage (47.1%) than the PNC group (27.9%). Statistical analysis revealed age group distribution between the PNC and ANC subgroups was comparable(p=0.131).

Among the total of 60 cases, 71.7% were categorized under PNC, while 28.3% were associated with ANC. This distribution suggests a higher prevalence of maternal deaths occurring during the postnatal period compared to the antenatal period in the study population.

Table 2: Distribution of Maternal deaths

Period of death	**Number**	**%**
Antepartum(n=17)		
1st trimester	2	11.76
2nd trimester	4	23.53
3rd trimester	6	35.29
Not known	5	29.41

Period of death	**Number**	**%**
Postpartum (n=43)		
<12 hrs	6	13.95
12hrs-24 hrs	4	9.3
1 day	8	18.6
2 days	2	4.65
3 days	3	6.98
4 days	1	2.33
5 days	2	4.65
6 days	1	2.33
10 days	2	4.7
Not known	14	32.6
Average duration	2.3±2.1 days	

In postpartum period maximum deaths were within 24hrs whereas for antepartum period maximum deaths were found in 3rd trimester. The maximum period of death reported was postpartum 10 days whereas, average duration of death for postpartum period was 2.3±2.1 days.

Table 3: Cause of mortality between study groups

Cause of mortality		**PNC (n=43)**	**ANC (n=17)**	**Total**	**P**
Indirect	Number	13	5	18	0.97
	%	30.20%	29.40%	30.00%	
Direct	Number	24	10	34	
	%	55.80%	58.80%	56.70%	
cause not established	Number	6	2	8	
	%	14.00%	11.80%	13.30%	

There was no significant difference in the distribution of causes of mortality between the PNC and ANC group (p = 0.97). In overall 13.3% cases, cause of death could not be established either due to lack of history or due to poor condition of the viscera received. Both groups had comparable proportions of indirect (30.2% vs. 29.4%), direct (55.8% vs. 58.8%), and undetermined causes (14.0% vs. 11.8%) of maternal death.

Table 4: Causes of maternal mortality

Direct(n=34)		
Cause of death	**No. of deaths**	**%**
Postpartum Haemorrhage	15	44.1
Eclampsia and preeclampsia	8	23.5
Sepsis(purpureal)	6	17.6
DIC	2	5.88
Ruptured ectopic pregnancy	1	2.9
Abortion	1	2.9
Chorioamnionitis	1	2.9
Indirect(n=18)		
Cause of death	**No. of deaths**	**%**
Pneumonia	2	11.1
Anemia	6	33.3
Venous thromboembolism	1	5.6
Liver haemorrhagic necrosis	3	16.7
Acute febrile illness	4	22.2
Acute myocarditis	2	11.1

Among direct causes (n=34), postpartum haemorrhage accounted for the highest proportion (44.1% of the total direct cases), followed by eclampsia and preeclampsia at 23.5% each. Sepsis and DIC contributed 17.6% and 5.8%, respectively. Chorioamnionitis, ruptured ectopic and abortion collectively represented 2.9% of deaths among direct cases. Indirect causes (n=18) included anemia (33.3% of the total indirect cases), acute febrile illness (AFI) (22.2%), liver haemorrhagic necrosis

(16.7%), acute myocarditis and pneumonia each contributed to 11.3%. venous thromboembolism contributed to 5.6% of deaths among indirect cases.

GROSS FINDINGS

Figure No. 1: ***Gross of cerebrum showing Subarachnoid Haemorrhage***

MICROSCOPIC FINDINGS

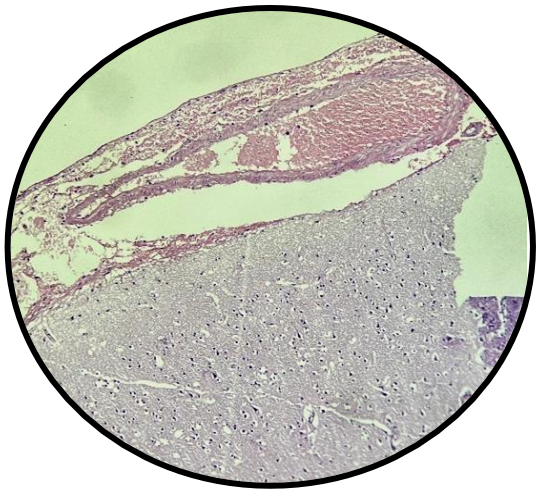

Figure No. 2: Subarachnoid haemorrhage in Cerebrum (paraffin, H&E 400X)

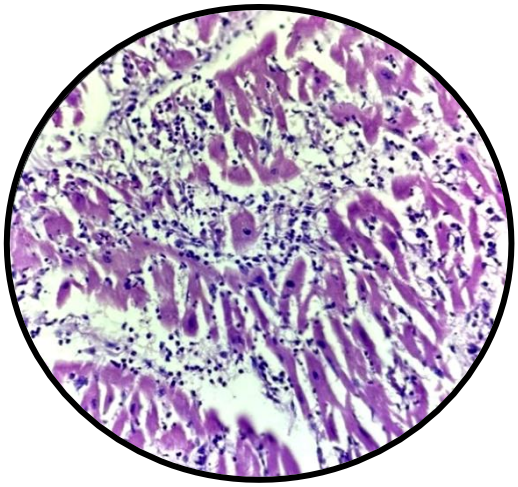

Figure No. 3: Diffuse polymorphonuclear cell infiltration in between cardiac myocytes(paraffin, H&E 400X)

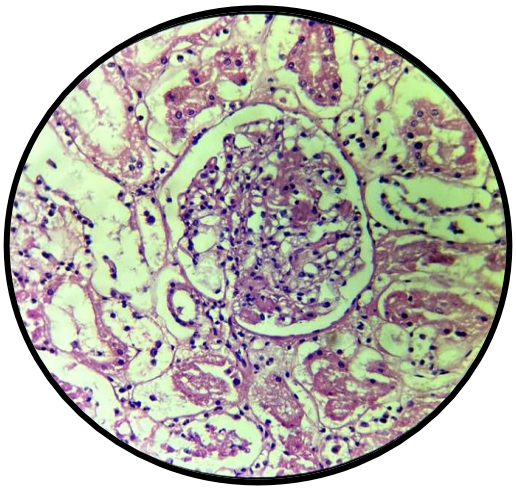

Figure No. 4(a): Fibrin thrombi in glomeruli and glomerular capillaries (paraffin, H&E 400X)

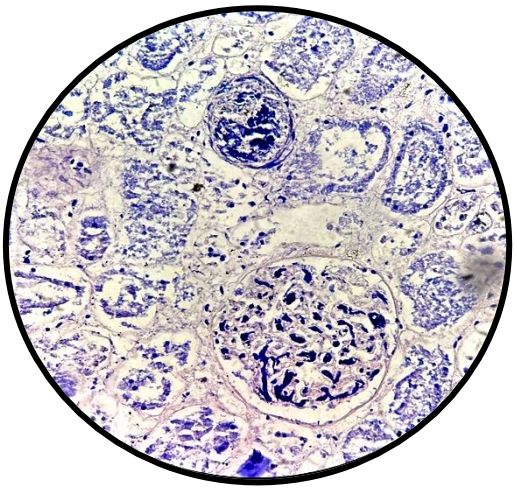

Figure No. 4(b): Fibrin thrombi showing deep blue colour on PTAH staining (paraffin, PTAH stain-400X)

DISCUSSION

Globally, maternal mortality is a serious health concern for many developing nations. According to a report by the World Health Organization (WHO), it is asserted that the majority of women who succumb during childbirth reside in underdeveloped nations. Furthermore, the preventable nature of these fatalities should serve as a catalyst for mobilizing resources and implementing measures aimed at mitigating maternal mortality. The autopsy defines the course of events leading to death in addition to assisting in determining the precise cause of death (15). This study conducted at a tertiary care centre on pathological aspects of maternal mortality provides crucial insights into various dimensions of maternal health, shedding light on demographic characteristics of deceased mothers, their gestational history and the underlying direct and indirect causes of mortality.

The age prevalence of maternal mortality is notably skewed towards younger women, particularly within the age brackets of 21-25 and 26-30 years, as indicated by the present study. This finding is consistent with prior research conducted by Mootha et al., which reported that 80% of maternal deaths occurred among women aged 20 to 29 years.(16) Similarly, a study conducted in Germany by Buschman et al. found that 71.5% of maternal deaths occurred in the 21–30 years age group. (17) The commonality of maternal deaths among younger women can be attributed to the fact that the childbearing age typically ranges from 20 to 30 years.

The majority of deaths during the postnatal period occurred within the first 24 hours. These findings were comparable to those in study done by Dol J et al. who found that day 1 had the largest proportion of postpartum maternal deaths (48.9%), with 24.5% of deaths occurring between days 2 and 7.(18) The findings from the present study in line with past studies, underscore a significant prevalence of maternal deaths during the third trimester of pregnancy. We observed a substantial proportion (35.29%) of antenatal deaths occurred during the third trimester. Similarly, Buschman et al. reported that 46.2% of maternal deaths in their study population occurred during this period, while Kavatkar et al. found an even higher percentage of deaths (52.6%) in the third trimester(19).
In present study we found that 56.6% of the women died because of the direct causes which is lower than the results of review of Global causes of maternal death using 23 studies performed by WHO which has reported that nearly 70% of maternal deaths were due to direct obstetric causes worldwide (20).

Among direct causes, haemorrhage accounted for 44.1% of maternal mortality cases, while eclampsia and preeclampsia accounted 23.5% of the direct causes in present study.

The findings from the present study indicate that postpartum haemorrhage, hypertensive diseases of pregnancy (eclampsia and preeclampsia), and sepsis are significant direct causes of maternal mortality, accounting for 44.1%, 23.5%, and 17.6% of cases, respectively. These results are consistent with a WHO review, which reported haemorrhage as the leading cause at 27.1%, followed by hypertensive disorders at 14.0%, and sepsis at 10.7%. Similarly, a recent study from Ethiopia by Sara et al. identified haemorrhage, hypertensive disorders of pregnancy, and obstructed labour as the most important direct causes of maternal mortality. (21) Additionally, Ikhtiar et al. highlighted obstetric haemorrhage, puerperal sepsis, and pregnancy-induced hypertension as significant contributors (22). In present study 30% of the women died due to indirect causes among which severe anemia and Acute febrile illness were the most common. As per the WHO reports 20-25% of the maternal mortality is due to the indirect causes which agrees to present study findings. A recent study by Sara et al showed that about 14% of the maternal deaths were due to indirect causes in last three years from 2019. WHO reports the common indirect causes of maternal mortality as anemia, malaria, HIV/AIDS, diseases of the heart, lung, liver or kidneys. In present study findings are in accordance with the WHO reports. (23)

The significance of our study lies in the crucial role of autopsy examinations in investigating maternal mortality. While autopsies may unveil unexpected diseases, they also help negate suspected complications. In India, many mothers arrive at hospitals during delivery or with limited time for antenatal check-ups, missing opportunities to address issues like anemia or infections. Insights gained from this study offer vital guidance for formulating community-specific strategies in order to achieve The Sustainable Development Goal to decrease maternal mortality to below 70 maternal deaths per 100,000 live births by the year 2030.

One of the limitations of present study is the failure to determine the cause of death in 13.3% of cases. This was primarily due to either insufficient clinical history. Despite efforts to gather comprehensive data, the lack of complete medical records or the compromised state of the tissue samples hindered accurate determination. This limitation underscores the challenges inherent in conducting postmortem analyses, emphasizing the need for improved documentation practices and enhanced preservation techniques to ensure the thorough investigation of maternal mortality cases.

CONCLUSION

Histopathological analysis should be done in suspected maternal or pregnancy-related deaths to provide detailed insights into potential underlying causes of death. Direct causes such as haemorrhage and hypertensive diseases of pregnancy continue to contribute significantly to maternal mortality rates, despite being preventable.

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