

ORIGINAL ARTICLE

MICROSCOPIC ANALYSIS OF HEARTS AND REVISIT OF MEDICO-LEGALLY SIGNIFICANT DEATHS CONCLUDED AS ISCHEMIC HEART DISEASE IN A TERTIARY CARE HOSPITAL IN SRI LANKA

Rajakarunanaik NNVD^{1*}, Kitulwatte IDG²

¹Office of the Judicial Medical Officer, Teaching Hospital, Batticaloa, Sri Lanka

²Department of Forensic Medicine, Faculty of Medicine, University of Kelaniya, Ragama, Sri Lanka

ABSTRACT

Introduction: Interestingly, the heart has the most frequent diagnostic agreement and the least refinements after histological examination. However, few studies have found a diagnostic disharmony after histological examination. In routine practice, it is usual to give the cause of death as Ischemic Heart Disease (IHD), especially with the positive clinical history and suggestive gross pathology in Sri Lanka.

Objectives: We designed this study to determine the importance of microscopic findings in concluding the cause of death as IHD.

Methods: A retrospective review of the autopsy reports of the cases concluded as IHD was conducted, and the cardiac sections obtained at autopsy were reviewed microscopically.

Results: Among the total sample of 100 autopsies, the microscopic sections had been obtained only for academic purposes in 60% of cases where the cause of death had been concluded as IHD based on gross pathology and the clinical picture. At the microscopy review, positive histopathological findings were identified in 69%, and out of them, findings confirmed the macroscopic cause of death in 57%. In contrast, 9% had revealed a different cardiac cause of death. There were 22% autopsies with negative microscopy, even though the cause of death had been concluded as IHD based on gross pathology and clinical history.

Conclusions: The study reiterates the importance of microscopy in concluding the cause of death as IHD, even though the macroscopic examination could offer crucial initial insights. The findings highlight the need for improved integration of histopathology into routine forensic practice and underscore its significance in achieving accurate cause-of-death.

Corresponding Author: Rajakarunanaik NNVD

vianney8@gmail.com

 <https://orcid.org/0009-0009-1816-8702>

ARTICLE HISTORY:

Received: 01.01.2025

Received in revised form: 16.05.2025

Accepted: 28.05.2025

Available online: 30.06.2025



This article is licensed under the terms of the Creative Commons Attribution-Non Commercial 4.0 International License.

Keywords: *Discrepancy; histopathology; ischemic heart disease; medico-legal autopsy*

INTRODUCTION

The autopsy is important in establishing the cause of death accurately in natural deaths as well as in the event of unnatural deaths. In the process of administration of justice, courts tend to rely heavily on the postmortem report, which an expert in this field must conduct. The autopsy report is expected to reveal the truth that could not be picked up by clinicians or radiologists in

their investigations. Therefore, it is considered a gold standard in certifications of death.

The cause of death may look quite obvious, especially in mechanical injuries. However, determining the exact manner of death and the conditions contributing to death can be problematic¹. Forensic experts are expected to reveal the natural pathologies that either caused or contributed to death after a thorough autopsy and ancillary tests, even though there is a high rate of non-natural deaths. However, it is well known that most experts rely primarily on gross or macroscopic pathology to come to conclusions. Most of the Judicial Medical Officers in Sri Lanka conclude the cause of death based on gross findings and await microscopic results to conclude the cause of death only in required cases. This is mainly due to a lack of facilities in most centres to cope with the workload. However, a significant number do obtain samples for microscopy.

Forensic histopathology is an instrumental ancillary test in the case of a sudden death, which could be a purely natural death or where trauma and poisoning need to be ruled out. Further, it plays an important role when a trivial trauma worsens or augments the progression of the disease.

A retrospective study by Nashelsky and Lawrence on natural deaths has found that most presumed and actual causes of death were cardiovascular, and the majority were due to ischemic heart disease. However, the presumed cause of death was found to be wrong in 28% of cases². Ischemic heart disease (IHD), also known as coronary artery disease, represents a group of pathophysiologically related syndromes resulting from myocardial ischemia³.

In routine practice, it is usual to give a cause of death (COD) as IHD based purely on the clinical picture and macroscopic findings. However, other cardiac pathologies such as myocarditis, deposition diseases such as amyloidosis, and inflammatory diseases such as sarcoidosis, etc. may be misinterpreted as IHD when concluding based on gross color changes of the myocardium at autopsy such as redness, paleness, the grey-white scar of fibrosis, leading to an incorrect cause of death.

The heart is the organ with the most frequent diagnostic agreement and, interestingly, with the least diagnostic refinements after histological examination. One possible explanation for this finding is that the heart is frequently affected by vascular disorders, leading to acute or chronic ischemic or hemorrhagic changes that are usually obvious macroscopically⁴.

Few studies have addressed the issue of diagnostic changes after histological examination in different organs at necropsy⁴. Discordance between the macroscopic and microscopic evaluation of the heart (coronary artery atherosclerosis) by Kandy *et al.* (2014)⁵ found 13.5%, Bernadi *et al.* (2005)⁴ found 22.56%, Neil *et al.* (2006) found 30.43%, and Mangal *et al.* (2007) found 17.14%⁴. Myocardial infarction was among the diseases that were correctly diagnosed in more cases than not. In studies correlating clinical diagnoses with autopsy findings, many have reported similar results, except for cases in which the patient had chronic myocardial ischaemia. In the group of "false" infarctions that were clinically suspected but not revealed at autopsy, the underlying cause was frequently pulmonary embolism. Cameron and McGoogan *et al.* indicated that such conditions as acute abdominal and pulmonary embolism, which most frequently mimicked infarction in their study, produced similar clinical features, i.e., acute pain, shock, or a combination of the two⁶. Over 20% of clinically unexpected autopsy findings, including 5% of significant findings, can be correctly diagnosed only by histological examination⁷.

We designed a retrospective descriptive study to determine the importance of microscopic findings in concluding the cause of death as IHD and to evaluate the microscopic findings in relation to the described gross pathology.

METHODS

We reviewed the cardiac microscopic slides of cases where the cause of death was given as "ischaemic heart disease," "atherosclerotic heart disease," or "occlusive coronary artery disease," or the cause of death was contributed by any of the above IHDs (acute myocardial infarction [MI], chronic IHD with sudden arrhythmia or heart failure, or sudden cardiac death) according to the postgraduate trainees who performed autopsies

at a major teaching hospital, during a period of 1 year (from 2022 January to 2023 January). The postmortem reports of the above cases were perused to obtain the historical and gross pathological findings to fill the proforma.

All the data were recorded in the printed proforma and then transferred to a Microsoft Excel spreadsheet for data analysis.

Histology review of prepared slides

All the slides about the individual cases were examined for the specific objective by the principal investigator and the supervisor. A qualitative grading to assess the level of achievement of the specific objectives developed by Bandara *et al.* in their study “A retrospective study to evaluate the significance of routine and special histopathological investigations and their application by the experts in medico-legal autopsies conducted at Teaching Hospital Ragama”⁸ was modified and used as follows in this study (Table 1).

Table 1: Qualitative grading to assess the level of achievement of the objective.

Level of achievement	Observation
A	Positive histological findings were identified, and the cause of death could be ascertained
A-1	Findings revealed the cause of death (COD), which was not identified macroscopically.
A-2	Findings confirmed the macroscopic COD /probable COD.
A-3	Findings can be used to exclude possibilities other than COD.
B	Positive histological findings were identified, but the cause of death could not be ascertained.
B-1	Findings are not compatible with macroscopic findings.
B-2	Findings are not significant/relevant to the COD.
B-3	Findings cannot be used to confirm COD or to draw any other conclusions.
C	No histological findings were identified.

RESULTS

Demographic Characteristics

The total sample included 100, based on the yearly postmortem statistics of the centre during the period from January 2022 to January 2023.

In terms of gender, a majority were male, amounting to 73% of the total sample, and even though the majority (53%) were above 40 years of age, there was a surprising 20% of the sample comprised of those between the ages of 30 and 39 years (Table 2).

Table 2: Age distribution of the sample

Age groups	Frequency
18 - 29 years	4
30 - 39 years	20
40 - 49 years	25
50 - 59 years	28
60 - 70 years	23
Total	100

Preceding clinical history of IHD

Interestingly, a majority of 52% had only had a short duration of illness, and 34% of the subjects did not have an adequate clinical history available at the time of death (Table 3).

Table 3: Preceding clinical history of IHD

Category of clinical history	Frequency
Long duration of ill health	4
No proper history was available	34
Short duration of ill health	52
Documented evidence of IHD is available	8
Other	2
Total	100

The conventional practice of performing histopathology in our setting

In 60%, a histopathology slide review had yet to be performed, even though the samples had been obtained for academic purposes. However, a notable 39% was performed to confirm the ascertained cause of death, 3% to define the contributory causes for the cause of death, and 1% to find the cause of death itself, where macroscopic examination alone was inconclusive. (Note that the percentages stated above override, as multiple purposes have been quoted in certain records.)

Level of achievement of the objectives

As described above, a qualitative grading was used to assess the level of achievement of the objectives of the study. The respective grades achieved have primarily been divided under the umbrella groups 'A' (those where positive histological findings were identified and the cause of death had been ascertained), 'B' (those where positive histological findings were identified but the cause of death could not be ascertained), and 'C' (where histological findings have not been identified). Of the total, in 78% of the samples, positive histological findings were identified, of which in 88% (n=69), the cause of death could be ascertained, and in the remaining 12% (n=9), it could not be (Table 4).

Further to the data outlined above, of the 69% of the total samples where positive histological findings were identified and the cause of death ascertained, 57% confirmed the macroscopic cause of death that had been proposed. Of the remainder of this proportion, 9% revealed the cause of death in cases where it had not been identified macroscopically prior to it. In another 3%, the histological evidence was instrumental in excluding other possible causes for the death.

It was also evident that in 4% of the sample, the histological findings were incompatible with the macroscopic findings. On the other hand, in 22% of the samples, no histological findings were identified despite the cause of death being decided upon as ischaemic heart disease (and its relevant conditions stated earlier on) through macroscopic findings and historical evidence.

Table 4: The relevant proportions of the levels of achievement of the objectives

Level of achievement	Observation	The proportion of the total sample that had achieved relevant grade
A	Positive histological findings were identified, and the cause of death could be ascertained.	69%
A1	Findings revealed the COD, which was not identified macroscopically	9%
A2	Findings confirmed the macroscopic COD /probable COD.	57%
A3	Findings can be used to exclude possibilities other than COD.	3%
B	Positive histological findings were identified, but the cause of death could not be ascertained.	9%
B1	Findings are not compatible with macroscopic findings	4%
B2	Findings are not significant/relevant to the COD	0%
B3	Findings cannot be used to confirm COD or to draw any other conclusions.	5%
C	No histological findings were identified.	22%

DISCUSSION

In forensic medicine, accurate diagnosis through autopsy is paramount for judicial processes, and histopathological examination can provide invaluable insights that may otherwise be missed by gross inspection alone. The Royal College of Pathologists in 2002 recommended histological sampling of all major organs as part of a complete autopsy in its guidelines on autopsy practice⁹. Lack of histology significantly detracted from the quality of the autopsy report in 28% of reports examined by the National Confidential

Enquiry into Perioperative Deaths (NCEPOD) of the United Kingdom in their 2001 report, in which only some papers specifically examined histology¹⁰. Those that did showed that diagnoses made on macroscopic examination were altered by histology and that macroscopically normal organs showed histological abnormalities. Microscopy gave diagnoses not made macroscopically in 5% of primary diagnoses and 23% of all unexpected diagnoses in one study¹¹.

The majority of this sample who had deaths due to or associated with IHD were in the age group above 40 years of age, as expected. However, interestingly, there was a significant proportion of deaths in the age group of 30 to 39 years. This may have been contributed mainly by the absence of preceding illness or diagnosis among the young, leading the inquirers to order a compulsory autopsy. At the same time, among the older age group with preceding clinical diagnoses, an inquest may not be indicated, and even after an inquest, there is a probable cause of death to satisfy the inquirer. According to a current review of literature by Abbas *et al.*, sudden cardiac deaths are less common in the age group below 35 years¹². However, a study among Italian students aged 13 to 19 detected significant ECG abnormalities among 13%¹³. A study on sudden unexpected deaths autopsied at a tertiary care hospital in Sri Lanka revealed that 50% of the deaths were due to cardiac causes¹⁴.

The absence of a preceding history was observed among 52% of the cases, which is self-explanatory since the sample is from the group that had undergone a medico-legal autopsy. However, sudden cardiac death is a well-recognised presentation of ischaemic heart disease¹⁵. On the other hand, the lack of comprehensive clinical data further emphasises the critical role of autopsy in uncovering undiagnosed pathologies and ensuring that the actual cause of death is identified. The absence of a detailed clinical history reinforces the need for forensic pathologists to rely on gross and microscopic findings to reach an accurate conclusion⁵. The findings of this study revealed that histopathological examination had a significant impact on the accuracy of the cause of death determination in 59% of the cases, with the majority confirming macroscopic findings.

However, importantly, in 9% of the cases, microscopy revealed a cause of death that was not identified in the gross examination. This corroborates previous studies that emphasise the importance of microscopic examination in cases of heart disease, where subtle or complex pathologies may not be readily apparent on gross inspection. For example, conditions like MI, myocarditis, and deposition diseases such as amyloidosis or inflammatory diseases such as sarcoidosis can be easily misinterpreted as IHD based solely on macroscopic features such as the colour changes of the myocardium, fibrosis, or the presence of atherosclerosis^{5,16}. By offering a more detailed analysis of myocardial tissue, histopathology can help distinguish these conditions and thus refine the cause of death. Furthermore, the microscopic slides can be used as reviewable evidence, especially in controversial cases. The significant percentage (57%) of cases in which histological findings confirmed the macroscopic diagnosis aligns with findings from other studies showing a high rate of diagnostic agreement between gross and microscopic heart examination^{4,17}.

On the other hand, in 9% of the cases, microscopy revealed a cause of death that was not identified in the gross examination. There was another 9% where the microscopic findings were nonspecific, and the findings were either incompatible with the gross findings (4%) or could not be used to reach conclusions (5%). All these instances could be considered diagnostic errors since all these cases have already been concluded as ischaemic heart disease based on clinical history and gross pathology. These instances highlight the potential for errors in diagnostic interpretation during the macroscopic phase, underscoring histopathology's importance in verifying and ruling out other possible causes¹⁸. This is further highlighted by the fact that 22% of cases had no positive histological findings despite a definitive COD being reached based on macroscopic observations and historical data. The finding reiterates the importance of microscopy and suggests the possibility of misdiagnosis from gross pathology. However, in some instances, the macroscopic and clinical evidence alone may be sufficient to ascertain the cause of death, especially in well-documented cases of IHD⁹.

Interestingly, only 39% of the cases underwent histopathological examination to confirm the cause of death, despite 60% having histology samples collected. This highlights an important challenge in forensic practice, particularly in settings with limited resources or high caseloads. Given that histological examination significantly contributes to the accuracy and comprehensiveness of postmortem investigations, this finding calls for a review of practices regarding the routine use of histopathology in autopsies, especially for cases involving IHD and other cardiovascular conditions¹⁰.

The study also points to the broader implications of forensic histopathology, including its potential to detect inherited cardiac diseases that may pose a risk to surviving family members, such as cardiomyopathies. Identifying such conditions could not only aid in public health but also inform clinical management for relatives, potentially preventing further fatalities due to undiagnosed cardiac conditions. This aspect aligns with the growing recognition of forensic medicine's role in providing valuable information for medical practitioners and the public¹⁶.

In conclusion, this study reinforces the essential role of histopathology in forensic autopsies, particularly in cases where the cause of death is initially suspected to be ischaemic heart disease. While macroscopic examination offers crucial initial insights, histopathological examination often provides definitive answers, clarifies diagnostic uncertainties, and identifies conditions that may be overlooked. Furthermore, histopathology is also a useful tool in excluding microscopic pathologies of the heart in cases of sudden cardiac death in the young, so that inherited cardiac conditions such as channelopathies can be screened for in the next of kin. The findings highlight the need for improved integration of histopathology into routine forensic practice and underscore its significance in achieving accurate cause of death determinations, ultimately enhancing the quality of autopsy reports and supporting the broader medico-legal process. Future studies could explore the impact of improving histopathological access and protocols in resource-limited settings, aiming to further

optimise the diagnostic accuracy and clinical utility of forensic autopsies.

LIMITATIONS OF THE STUDY

As this was a retrospective study, carried out by examining the slides obtained by postgraduate trainees, it is impossible to corroborate the exact locations the samples were obtained from the heart. Furthermore, fixation and processing artefacts, especially concerning cross sections of coronary arteries, may have impacted the findings to a certain extent.

ACKNOWLEDGEMENTS

None.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

The ethical approval for this study was granted by the Ethics Review Committee, Faculty of Medicine, University of Kelaniya, Ragama, Sri Lanka (Ref. No.: P/48/05/2021).

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

NNVDR: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and reviewing it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **IDGK:** Conception and design of the work; drafting the work and reviewing it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

- Kircher T, Anderson RE. Cause of death: Proper completion of the death certificate. *The Journal of the American Medical Association*. 1987 Jul 17;258(3):349-52. <https://doi.org/10.1001/jama.1987.03400030065033>.
- Nashelsky MB, Lawrence CH. Accuracy of cause of death determination without forensic autopsy examination. *The American Journal of Forensic Medicine and Pathology*. 2003 Dec;24(4):313-9. <https://doi.org/10.1097/01.paf.0000097857.50734.c3>.
- Kumar V, Abbas AK, Astor JC. *Robbins and Cotran Pathologic Basis of Disease*. 9th ed. Elsevier; 2014.
- Bernardi FDC, Saldiva PHN, Mauad T. Histological examination has a major impact on macroscopic necropsy diagnoses. *Journal of Clinical Pathology*. 2005 Dec;58(12):1261-4. <https://doi.org/10.1136/jcp.2005.027953>.
- Kandy NC, Pai MR, Philipose R. Role of histopathology on autopsy study: An audit. *SAS Journal of Medicine*. 2015;1(1):7-15.
- Stevanovic G, Tucakovic G, Dotlic R, Kanjuh V. Correlation of clinical diagnoses with autopsy findings: a retrospective study of 2,145 consecutive autopsies. *Human Pathology*. 1986 Dec;17(12):1225-30. [https://doi.org/10.1016/S0046-8177\(86\)80564-0](https://doi.org/10.1016/S0046-8177(86)80564-0).
- Roulson J, Benbow EW, Hasleton PS. Discrepancies between clinical and autopsy diagnosis and the value of post mortem histology; a meta-analysis and review. *Histopathology*. 2005 Dec;47(6):551-9. <https://doi.org/10.1111/j.1365-2559.2005.02243.x>.
- Bandara KPS, Kitulwatte IDG. Significance of histopathological investigation in medico-legal autopsies; A retrospective review. *Proceedings of the Annual Academic Sessions of the College of Forensic Pathologists of Sri Lanka*. 2018.
- Lee JA. Guidelines on autopsy practice. Report of a working group of the Royal College of Pathologists. *The Royal College of Pathologists*. 2002. Available from: <https://www.ihrdni.org/314-008-1.pdf>.
- Callum KG, Carr NJ, Gray AJG, *et al*. Functioning as a team?: The Report of the National Confidential Enquiry into Perioperative Deaths. London; 2002. Available from: <https://ncepod.org.uk/2002report/Datasupplement2002.pdf>.
- Zaitoun AM, Fernandez C. The value of histological examination in the audit of hospital autopsies: a quantitative approach. *Pathology*. 1998 May;30(2):100-4. <https://doi.org/10.1080/00313029800169036>.
- Abbas R, Abbas A, Khan TK, Sharjeel S, Amanullah K, Irshad Y. Sudden cardiac death in young individuals: A current review of evaluation, screening and prevention. *Journal of Clinical Medicine Research*. 2023 Jan;15(1):1-9. <https://doi.org/10.14740/jocmr4823>.
- Zorzi A, Vessella T, De Lazzari M, *et al*. Screening young athletes for diseases at risk of sudden cardiac death: role of stress testing for ventricular arrhythmias. *European Journal of Preventive Cardiology*. 2020 Feb;27(3):311-320. <https://doi.org/10.1177/2047487319890973>.
- Kitulwatte IDG, Edirisinghe PAS. Sudden unexpected deaths of young adults in a tertiary care hospital for a period of four years. *Medico-Legal Journal of Sri Lanka*. 2014;2(1):15-21. <https://doi.org/10.4038/mlj.v2i1.7308>.
- Gräni C, Benz DC, Gupta S, Windecker S, Kwong RY. Sudden cardiac death in ischemic heart disease: From imaging arrhythmogenic substrate to guiding therapies. *Journal of the American College of Cardiology: Cardiovascular Imaging*. 2020 Oct;13(10):2223-2238. <https://doi.org/10.1016/j.jcmg.2019.10.021>.
- Cameron HM, McGoogan E. A prospective study of 1152 hospital autopsies: I. Inaccuracies in death certification. *The Journal of Pathology*. 1981 Apr;133(4):273-83. <https://doi.org/10.1002/path.1711330402>.
- Neil DAH. Transplant Pathology. In: Suvarna S. (eds) *Cardiac Pathology*. Springer, Cham; 2019. https://doi.org/10.1007/978-3-030-24560-3_10.
- De Noronha SV, Behr ER, Papadakis M, *et al*. The importance of specialist cardiac histopathological examination in the investigation of young sudden cardiac deaths. *EP Europace*. 2014 Jun;16(6):899-907. <https://doi.org/10.1093/europace/eut329>.