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Chorioamnionitis in intrauterine fetal death: A forensic histopathological case study☆

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ABSTRACT

Introduction: Acute chorioamnionitis is a placental inflammatory condition often implicated in adverse pregnancy outcomes, including intrauterine death. The histopathological identification of maternal and fetal inflammatory responses (MIR and FIR) is critical for diagnosis and understanding potential causal mechanisms. Chorioamnionitis frequently warrants medico-legal investigation, particularly for suspected medical malpractice.
Material and methods: Two forensic cases of intrauterine fetal death with histological finding of acute chorioamnionitis are presented. Each case has been investigated with a complete autopsy with histological examination of fetal organs and placenta. The investigations were conducted following the Royal College of Pathologists' Guidelines on autopsy practice for fetal death and the European Guidelines for forensic investigations involving suspected healthcare professional liability.
Results and Discussion: In Case 1, histopathology revealed acute necrotizing chorioamnionitis associated with chorionic vasculitis, funisitis and fetal organ involvement (*stage* 3/*grade* 2 MIR; *stage* 2/*grade* 1 FIR), supporting a causal role in fetal death. In Case 2, only focal chorioamnionitis with minimal fetal inflammatory response (*stage* 2/*grade* 1 MIR; *stage* 1/*grade* 1 FIR) was detected. A definitive and certain causal relationship with the death cannot be established due to the absence of systemic fetal involvement. No substandard medical care was identified in either case.
Conclusion: These cases underscore the importance of integrating clinical and histological data to determine the pathophysiological significance of chorioamnionitis in fetal death. The evaluation of FIR and organ involvement are critical for distinguishing between causal and incidental findings. Thorough histopathological evaluation is essential for accurate cause of death determination and medicolegal assessment.

1. Introduction

Acute chorioamnionitis is an inflammatory process affecting the placental amniochorionic membranes, with or without an accompanying fetal inflammatory response. It typically arises in response to a microorganism infection, most commonly of bacterial or fungal origin, ascending from the cervicovaginal tract [1–3].

The diagnosis of chorioamnionitis can be established using histological, microbiological, biochemical, or clinical criteria; however, the gold standard is represented by histological examination [4,5].

Histological diagnosis is based on the microscopic identification of acute inflammation within the chorion and/or amnion of the amniochorionic membranes (i.e., amniotic sac) or chorionic plate, with or without the extravasation of fetal inflammatory cells from the umbilical cord vessels or the vessels of the chorionic plate [6]. Distinct histopathological patterns of maternal and fetal inflammatory responses have been associated with specific pregnancy outcomes [7,8].

The most widely accepted systems for staging and grading maternal

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and fetal inflammatory responses in ascending intrauterine infections are those proposed by the Amsterdam Placental Workshop Group (APWG) and those by the Armed Forces Institute of Pathology (AFIP) in collaboration with the American Registry of Pathology (ARP), adapted from Redline et al. [7,9,10]. According to these systems, *stage* refers to the anatomical progression of the inflammatory process, while *grade* indicates the intensity of the neutrophilic infiltrate at a particular site.

Chorioamnionitis occurs in up to 94 % of live births between 21 and 24 weeks of gestation and in approximately 5 % of full-term births. Among stillbirths, reported incidence rates range from 7 % to 96 % [3]. This condition is associated with increased morbidity and mortality in both mothers (e.g., surgical wound infection, bacteremia, septic shock, etc.) and fetuses (e.g., neonatal sepsis, periventricular leukomalacia, cerebral palsy, intrauterine death, etc.) [3]. Therefore, timely diagnosis and appropriate management are critical.

Given its potential impact of pregnancy outcomes, chorioamnionitis is frequently subject to medicolegal assessment, with particular focus on identifying any possible causal or contributory role in the determination of death in stillbirths. In the forensic context, this eventual role could have important legal consequence under both criminal and civil law, including issues of alleged medical negligence. In Italy, as in other European countries, the role of the forensic pathologist also includes evaluating the conduct of medical personnel in order to determine whether any errors were committed and, if so, to establish the causal link between those errors and the death.

We here report two cases of intrauterine fetal death subjected to forensic autopsy due to suspected medical malpractice, in which post-mortem histological examination revealed a diagnosis of acute chorioamnionitis. These cases highlight the importance of consistently performing a complete autopsy with histological sampling of the fetal organs, placenta and adnexa and underscore the fundamental role of the forensic pathologist in conducting a comprehensive assessment of histological findings, integrated with clinical and pathological data, to identify any possible causal or contributory role in the determination of death and assess potential medical malpractice.

2. Material and methods

Two cases of intrauterine fetal death were examined through the review of clinical documentation and a complete post-mortem external and internal examination. The forensic autopsies were performed according to the Royal College of Pathologists' guidelines on autopsy practice for fetal death in non-malformed fetuses [11] as well as to the most recent procedures endorsed by the European Guidelines for forensic investigations involving suspected healthcare professional liability [12].

During the autopsies, the brain was collected and en bloc removal of cervical, thoracic and abdominal organs was performed. The specimens were then fixed in 10 % buffered formalin. In Case 1, microbiological examination of the placenta and adnexa were not performed, as the placenta arrived to our Department already fixed in formalin. In Case 2, samples of placenta and adnexa were obtained at the hospital prior to fixation in formalin and were subsequently processed for microbiological analysis. A thorough examination of the fixed organs, placenta and adnexa was performed within three weeks. Tissue samples were collected from the central nervous system, thymus, heart, trachea and lungs, liver, spleen, pancreas, adrenal glands, kidneys, bladder and gastrointestinal tract, as well as from the placenta, chorionic membranes and umbilical cord, according to the Royal College of Pathologists' guidelines on histopathological examination of the placenta [13]. Subsequently, all specimens were dehydrated, paraffin-embedded, and stained with Haematoxylin and Eosin (HE) for histopathological evaluation. In addition, in Case 1, Gram and Grocott stain were performed on the amniochorionic membranes and PAS stain was performed for suspected cerebral embolus; in Case 2, CD15 stain were performed on the umbilical cord.

3. Case reports

Main macroscopic and histopathological findings are reported in Table 1 and Figs. 1 and 2.

3.1. Case 1

3.1.1. Clinical data

A 29-year-old pregnant woman at 22 + 5 weeks of gestation, in her second pregnancy, presented to the emergency department twice in the same day due to abdominal pain. The anamnesis showed a regular progression of the pregnancy. A gynecological examination, including ultrasound and cardiotocographic monitoring, was performed and documented no abnormal vaginal discharge, the presence of fetal cardiac activity and fetal movements, and the absence of uterine contractile activity. No clinical indication for hospitalization was identified, and the patient was discharged for the second time. Upon returning home, severely preterm spontaneous abortion occurred at a gestational age (GA) of 22 + 5 weeks.

3.1.2. Autopsy findings

The external examination revealed a normally developed male fetus, with auxological parameters and maturation consistent with gestational age and no evidence of malformations. The internal examination confirmed organ maturation appropriate for gestational age and, upon sectioning, pulmonary congestion; no other pathological findings or malformations were identified.

With regard to the placenta and placental annexes, inspection revealed slight thickening of the placental membranes, with a mildly opaque appearance and a whitish-green discoloration. The fetal surface of the placental disc showed a mildly opacified, greenish appearance. A 7 cm-long laceration was found on the maternal surface. Absence of true knots and significant hematomas of the umbilical cord. Dissection showed pale parenchyma with a minute area of hemorrhagic dissociation in the subchorionic region, 1 cm from the umbilical cord insertion, and marginal and subchorionic fibrin deposits.

3.1.3. Histological and histochemical findings

Marked multivisceral congestion was observed. The brain showed diffuse edema, congestion and vascular ectasia, both periventricular and intraparenchymal. Near the right lateral ventricle, a single vessel was suspected of containing fungal hyphae; therefore, we performed PAS staining, which allowed us to rule out the presence of a septic embolus. The lungs revealed hypoectasia and severe congestion, with focal areas of hemorrhagic dissociation in the subpleural, intraparenchymal, *peri*-adventitial regions and focally in the endoalveolar space. Bronchi, bronchioles, and alveoli were filled with amorphous eosinophilic material mixed with desquamated epithelial cells, lymphocytes, and neutrophilic granulocytes. Minimal interstitial edema was observed in the heart. Amorphous endoluminal material was present in the gastrointestinal tract, also incorporating isolated epithelial cells and some neutrophilic granulocytes. The kidney showed acute tubular necrosis and focal areas of hemorrhagic dissociation in the parenchymal and *peri*-adventitial regions.

The histological analysis of the placenta showed the presence of confluent maternal neutrophils with karyorrhexis, amniocyte necrosis, and hypereosinophilia of the amnion basement membrane; fetal neutrophilic infiltration was also observed, involving the wall of the chorionic vessels and the umbilical cord with development of arteritis and phlebitis. Histological examination also revealed the presence of blood clots with focal and early features of organisation, incorporating trophoblastic and decidual cells as well as phlogistic necrotic tissue. Furthermore, the basal plate showed decidual arteriolopathy characterized by fibrinoid necrosis and incomplete conversion of the decidual arteries, a finding indicative of maternal vascular malperfusion. In addition, intramural endovascular trophoblast and multinucleated

Table 1
Summary of macroscopic and histopathological findings.

Case	Fetus Macroscopic findings	Histopathological findings	Placenta and adnexa Macroscopic findings	Histopathological findings
Case 1	Normally developed male fetus. Lung congestion.	Brain edema with congestion, periventricular and intraparenchymal vascular ectasia. Lung congestion and hypoectasia; focal areas of hemorrhagic dissociation in the subpleural, intraparenchymal, *peri*-adventitial regions and focally in the endoalveolar space. Bronchi, bronchioles, and alveoli filled with amorphous eosinophilic material mixed with desquamated epithelial cells, lymphocytes, and neutrophilic granulocytes. Heart interstitial edema. Gastrointestinal tract with amorphous endoluminal material also incorporating isolated squamous cells and some neutrophilic granulocytes. Acute tubular necrosis and focal areas of hemorrhagic dissociation in parenchymal and *peri*-adventitial regions.	Placental membranes: slight thickening, mildly opaque appearance and whitish-green discoloration. Placental disc − fetal surface: mildly opacified greenish appearance, pale parenchyma with a minute area of hemorrhagic dissociation in the subchorionic region and marginal and subchorionic fibrin deposits. Umbilical cord: absence of true knots and significant hematomas.	Confluent neutrophils with karyorrhexis and hypereosinophilia of the amnion basement membrane. Amniocyte necrosis. Neutrophilic infiltration of the wall of the chorionic vessels and of the umbilical arteries and umbilical vein. Blood clots with focal and early aspects of organisation, incorporating trophoblastic and decidual cells and phlogistic necrotic tissue. Decidual arteriolopathy of the basal plate with aspects of fibrinoid necrosis and incomplete conversion of the decidual arteries. Presence of intramural endovascular trophoblast and multinucleated intermediate trophoblast cells. Gram and Grocott stains on the amniochorionic membranes: gram-positive bacterial colonies and fungal hyphae.
Case 2	Normally developed male fetus. Macerative phenomena involving perinasal region, neck, perianal region, left inguinal region, scrotum; overlapping of cranial bones.	Lung hypoectasia with keratin scales and pigments within the alveolar space.	Placental membranes: greenish discoloration, fibrin deposits in the marginal area. Umbilical cord: absence of true knots and significant hematomas.	Focal areas of neutrophilic infiltration of the chorionic plate, basal decidua, amniotic membrane. Neutrophilic infiltration of the wall of a large chorionic vessel. Placental chorangiosis and a focal hemorrhagic area in the amniotic membranes. CD15 stain on the umbilical cord: absence of granulocytic infiltration.

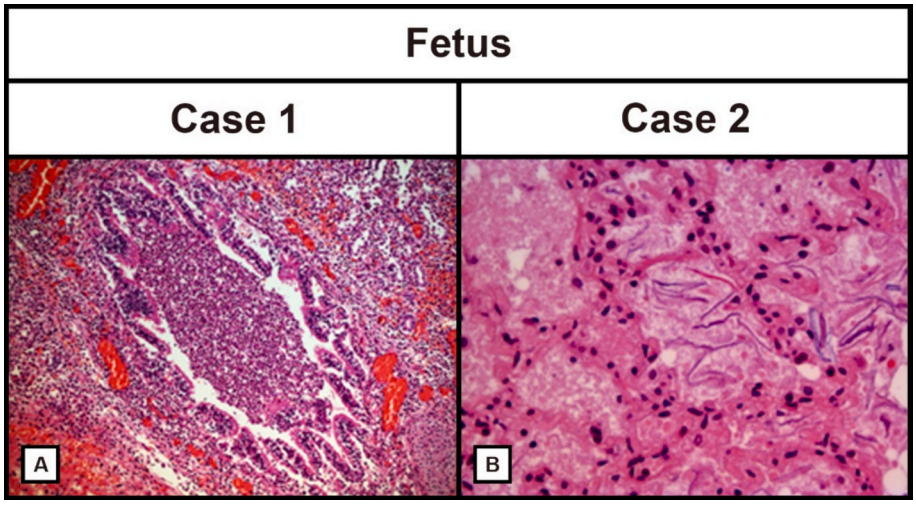

Fig. 1. Main histological findings of fetus in the two cases (A − Case 1; B − Case 2). A (HE stain, 50x): Bronchus and alveoli filled with amorphous eosinophilic material mixed with desquamated epithelial cells, lymphocytes, and neutrophilic granulocytes. B (HE stain, 400x): Keratin scales and meconium pigments within the alveolar spaces.

intermediate trophoblastic cells were observed. Histochemical analysis (Gram and Grocott stains) performed on the amniochorionic membranes revealed gram-positive bacterial colonies and fungal hyphae.

3.2. Case 2

3.2.1. Clinical data

A 32-year-old pregnant woman at 39 weeks of gestation, in her 1st pregnancy, presented to the maternity unit for routine evaluation. Although the pregnancy had progressed normally, due to suspected fetal macrosomia (estimated fetal weight 3910 g) a labour induction was initially planned at 39 + 5 weeks of gestation. However, because of a recent asymptomatic COVID-19 infection, the induction was postponed to 41 + 1 weeks of gestation. At the following pre-induction visit, the Sars-CoV-2 swab tested negative, but the absence of fetal heart activity was detected. Labour was then induced, resulting in a full-term stillbirth

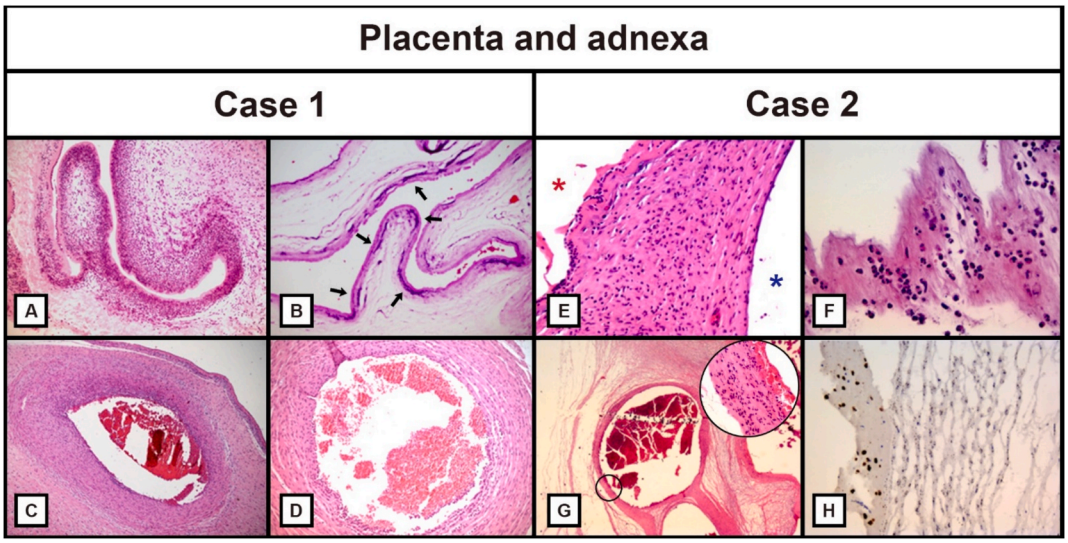

Fig. 2. Main histological findings of placenta and adnexa in the two cases (A, B, C, D — Case 1; E, F, G, H – Case 2). A (HE stain, 50x): Confluent maternal neutrophils, amniocyte necrosis, hypereosinophilia of the amnion basement membrane. B (Gram HC stain,100x): Amniochorionic membranes with presence of Gram-positive bacteria (arrows). C (HE stain, 25x): Fetal neutrophilic infiltration involving the wall of a large chorionic vessel. D (HE stain, 50x): Fetal neutrophilic infiltration involving the wall of an umbilical cord artery. E (HE stain, 200x): Maternal neutrophilic infiltration of the chorionic plate (maternal side, red asterisk – fetal side, blue asterisk). F (HE stain, 400x): Maternal neutrophilic infiltration of the amniotic membrane. G (HE stain, 25x): Fetal neutrophilic infiltration in the wall of a large chorionic vessel; a detail of the vase wall is shown inside the circle. H (CD15 IHC stain, 200x): No evidence of granulocytic infiltration in the wall of umbilical cord. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(GA 41 + 3).

3.2.2. Autopsy findings

The external examination revealed a normally developed male fetus, with auxological parameters and maturation consistent with gestational age, weighing 4200 g. No evidence of malformations was found. Macerative changes involving the skin of the perinasal region, neck, perianal region, left inguinal region, and scrotum were observed. The internal examination confirmed organ maturation appropriate for gestational age and revealed the overlapping of the cranial bones due to macerative phenomena. No other pathological findings or malformations were identified.

With regard to the placenta and adnexa, inspection revealed size consistent with gestational age and greenish-colored placental membranes. No true knots or significant hematomas were observed in the umbilical cord. Dissection showed fibrin deposits at the placental marginal area. The microbiological analyses, performed on the placenta, membranes, and umbilical cord after delivery, revealed a significant presence of *Escherichia coli* (E. Coli).

3.2.3. Histological and immunohistochemical findings

The lungs revealed hypoectasia and presence of keratin scales and pigments suggestive of meconium residues within the alveolar spaces. No evidence of significant pathological findings such as inflammatory or septic processes were found.

The histological analysis of the placenta revealed focal areas of neutrophilic infiltration of the chorionic plate, basal decidua, amniotic membrane and of a large chorionic vessel wall. Placental chorangiosis and a focal hemorrhagic area in the amniotic membranes were also found. No granulocytic infiltration of the umbilical cord was observed, even with the CD15 immunohistochemical stain.

4. Discussion

Intrauterine fetal death often represents a significant challenge for forensic pathologists, as in up to 50–60 % of cases, the cause of death remains undetermined despite comprehensive investigations [14,15]. Given this context, potential causes merit careful consideration, including intrauterine infection, placental insufficiency, growth restriction, malformations, and maternal conditions such as hypertension and diabetes.

In view of this, the presence of possible infection, such as chorioamnionitis, must always be thoroughly investigated in cases of intrauterine fetal death. From a forensic perspective, the identification and evaluation of chorioamnionitis are not limited to establishing a pathological diagnosis, but also extend to determining its causal relevance to death and assessing whether the clinical management was appropriate, as well as whether any potential errors identified had contribute to the pathological events that lead to death.

Bacterial or fungi microorganisms, the pathogens most frequently responsible for intrauterine infection, typically ascend from the vagina and uterine cervix, initially colonizing the choriodecidual space and eventually crossing intact amniochorionic membranes to involve the amniotic cavity and, in some cases, the fetus. At histological examination, the maternal inflammatory response (MIR) is observed when maternal neutrophils migrate from the decidual circulation into the extraplacental decidua, chorion and amnion, or the intervillous circulation into the chorionic plate and overlying amnion. Instead, the fetal inflammatory response (FIR) is represented by the fetal neutrophils' extravasation from fetal vessels in the umbilical cord or in the chorionic plate [2,3,6,8,16].

When the inflammation involves the fetal vessels (i.e., umbilical and chorionic vessels), several mechanisms have been described to explain fetal demise. One is the release of cytokines and other inflammatory mediators, leading to a systematic fetal inflammation, sepsis and multiorgan damage. Another mechanism is hypoxic injury resulting from inflammation and thrombosis within the umbilical vessels, which impairs placental perfusion and leads to fetal hypoxia [6,17].

Clinical diagnosis of chorioamnionitis is not always straightforward, as maternal fever may be the only sign, possibly accompanied by maternal or fetal tachycardia, leukocytosis, uterine tenderness on palpation, or rupture of membranes [18]. To allow early identification of an infection during pregnancy, it is essential to perform a vaginal-rectal swab [19]. Early diagnosis enables the prompt initiation of antibiotic therapy and the consideration of expediting labor induction. As chorioamnionitis is regarded as an inflammatory process of the

amniochorionic membranes, the definitive diagnosis must necessarily be histopathological, based on the microscopic evidence of membrane inflammation.

Given its potential impact of pregnancy outcomes, chorioamnionitis is frequently subject to medicolegal assessment, with particular focus on identifying any possible causal or contributory role in the determination of death in stillbirths. In the literature on the topic, the role of chorioamnionitis in fetal death remains a debated issue, with several studies reporting heterogeneous evidence regarding the possible association between its severity and fetal short- and long-term outcomes [4,5,7,20,21].

The two cases presented in this article involved intrauterine fetal deaths referred to us to assess potential malpractice and were investigated using a systematic post-mortem approach.

These cases were initially investigated through a review of the clinical records, which documented pregnancies with an uneventful course and no evidence suggestive of maternal infection, with the exception of SARS-CoV-2 in Case 2. At the examination of the placenta and adnexa, both cases exhibited a greenish discoloration of the placenta and membranes, findings consistent with an underlying inflammatory process. Histological examination subsequently confirmed the diagnosis of acute chorioamnionitis, which was then classified by stage and grade according to one of the main grading and staging systems for assessing the severity of acute chorioamnionitis, the model adapted from Redline et al. and proposed by the AFIP-ARP Atlas of Placental Pathology [10]. In Case 1, there was evidence of extensive neutrophilic infiltration with karyorrhexis involving the chorionic plate and fetal membranes, associated with amniocyte necrosis and marked hypereosinophilia of the amniotic basement membrane. These histopathological features are indicative of a maternal inflammatory response, as maternal-derived neutrophils had migrated from the intervillous space and the venules of the capsular decidua. The fetal inflammatory response was established by the identification of neutrophilic infiltration of the chorionic vessels (i.e. chorionic vasculitis) and the umbilical cord vessels (i.e. funisitis). In this context, the neutrophils are of fetal origin, having migrated from the fetal circulation. According to the aforementioned staging system, MIR was identified as *stage* 3, *grade* 2, consistent with a diagnosis of acute necrotizing chorioamnionitis, while FIR corresponded to *stage* 2, *grade* 1. The histochemical Gram-Grocott staining performed on the amniochorionic membranes revealed the presence of Gram-positive bacterial colonies and fungal hyphae. Histological analysis also revealed involvement of fetal organs, consistent with the fact that activation of the fetal vessel endothelium in the presence of funisitis may be accompanied by systemic endothelial activation, which can play a key role in the development of multiorgan damage [22].

Therefore, in Case 1, the presence of acute necrotizing chorioamnionitis with funisitis and chorionic vasculitis, in association with fetal organ involvement, strongly supports a crucial causal role of chorioamnionitis in the pathogenesis of death. The integration of clinical and autopsy findings led to the determination that the cause of death was acute heart failure due to acute necrotizing chorioamnionitis. Finally, the analysis of the medical conduct did not reveal any evidence of malpractice: in fact, pregnancy management was appropriate and the evaluation in the emergency department did not identify any maternal or fetal signs or symptoms suggestive of fetal distress or infection.

In Case 2, the histological analysis showed focal areas of neutrophilic infiltration of the chorionic plate, basal decidua and amniotic membrane, consistent with a *stage* 2, *grade* 1 MIR. The presence of neutrophils in the wall of a large chorionic vessel, without involvement of the umbilical cord, as confirmed by immunohistochemical analysis (CD15), represented a limited fetal inflammatory response, classified as *stage* 1, *grade* 1 FIR. In contrast to Case 1, histology did not reveal any organ damage, neither attributable to chorioamnionitis nor to other causes. Furthermore, a role of SARS-CoV-2 infection was ruled out based on the negative swab result and the absence of histopathological features associated with COVID-19-related fetal or placental pathology (e.g., intervillous thrombi, thrombotic vasculopathy, etc.) [23,24]. Finally, although macrosomia was slightly present (weight: 4200 g), no traumatic or metabolic complications were identified.

Therefore, despite the presence of a fetal inflammatory response with focal involvement of a chorionic vessel, and although chorioamnionitis is a recognized risk factor for intrauterine fetal death, a definitive causal relationship with the death cannot be established beyond any reasonable doubt due to the absence of systemic fetal involvement. Nonetheless, it remains plausible that a localized infection may have contributed to fetal compromise through mechanisms such as placental dysfunction or early inflammatory signaling, even in the absence of overt multiorgan injury. It should also be emphasized that, even in case of microbiological detection of a pathogen in the placenta and adnexa (i.e., E. Coli), this finding alone was not sufficient to confirm an active intrauterine infection or to establish a direct causal relationship with fetal death. In fact, without supportive histological evidence, such as funisitis, fetal sepsis, or organ damage, the presence of bacteria may reflect contamination rather than true infection. Indeed, as well documented in the literature, placental tissue often becomes contaminated as it passes through the nonsterile birth canal, hence representing a false positive infection [25,26]. Vaginal deliveries, such as in Case 2, are therefore more prone to false positive bacteriology results. An additional factor that may have contributed to contamination in this specific case is the artificial rupture of membranes, consistent with the literature [27]. Moreover, chorioamnionitis is usually polymicrobial [26,28]; however, in our case only E. coli was detected. It is therefore essential to interpret such microbiological findings in the context of the overall pathological and clinical picture, with the understanding that the mere presence of organisms in the placenta or fetus does not prove causality [5,28,29].

The analysis of the medical conduct did not reveal any evidence of malpractice. In fact, pregnancy management was appropriate and there were no obstetric-gynecological indications nor signs or symptoms suggestive of fetal distress or infection to justify early induction of labor.

In conclusion, in cases of intrauterine fetal death associated with histological evidence of acute chorioamnionitis, it is paramount for the forensic pathologist to evaluate the severity, extent, and fetal involvement in order to assess the pathophysiological role of infection in fetal demise. A thorough analysis of fetal organ damage attributable to the infectious insult, patterns of neutrophilic infiltration, and vascular involvement may be crucial to distinguish between causal, contributory, or incidental findings. In fact, the absence of such damage in Case 2 called into question the significance of chorioamnionitis in the pathogenesis of death, despite its presence. These evaluations are key not only for determining the cause of death but also for understanding the pathophysiological processes involved.

In the context of the medico-legal assessment of medical conduct, the evaluation of chorioamnionitis therefore represents a crucial step. The forensic pathologist must determine whether the inflammatory process was causally related to fetal death or played a marginal role. This determination requires an integrated evaluation of histopathological data together with clinical and obstetric information. In particular, the staging and grading of chorioamnionitis, through the evaluation of the MIR and, above all, the FIR, along with the evaluation of organ involvement, allows for the understanding of the evolutionary stage of the inflammatory process and its consequent effects on the fetus. After reconstructing the pathophysiological sequence of events, the forensic pathologist must correlate these findings with the clinical management, evaluating whether any deviations from the accepted standard of care might have contributed to the pathological events and, ultimately, to the fatal outcome.

The two cases presented in this article exemplify the need for this integrated forensic approach. In both cases, histological examination confirmed acute chorioamnionitis, although the severity and systemic repercussions differed markedly. Besides, in both cases, the forensic pathologist concluded that clinical management adhered to the accepted standards of care, and no errors were identified that could have cause or

contribute to the infection.

Furthermore, the two cases highlight the importance of a thorough histopathological evaluation in fetal death, as the underlying pathophysiological mechanism may vary considerably depending on the severity and extent of both maternal and fetal inflammatory responses. The involvement of the umbilical cord and evidence of fetal organ pathological changes represent crucial indicators of systemic compromise and must be interpreted within the overall clinical and pathological framework. A systematic and integrated forensic approach is therefore essential to distinguish infection-related fetal deaths from unexplained intrauterine deaths and to ensure accurate diagnostic conclusions.

Informed Consent Statement.

Given that these cases concerned two deaths under criminal investigation, authorization for publication was granted by the Judicial Authority.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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