Petechial Hemorrhage of the Conjunctiva and Histological Findings of the Lung and Pancreas in Infantile Asphyxia
—Evaluation of 85 Cases—

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Summary: Eighty-five cases of infantile asphyxia were examined in relation to the degree of conjunctivae petechial hemorrhages and histological and immunohistochemical findings of the lungs and the pancreas. In very young cases, even in the strangulation cases, conjunctivae petechial hemorrhages were unremarkable and sometimes absent. The lungs showed remarkable to moderate congestion, while the pancreas showed only slight to moderate edema and cell infiltrations. Many pancreata of cases of accidental and homicidal asphyxia had hyperplasia and nesidioblastosis of islet cells. In adult asphyxia cases, remarkable congestion has been the main finding in the lungs and the pancreas. This study shows many similarities between the findings in homicidal suffocation and in genuinely accidental suffocation, both in inspection and on histological examination. So, we here, stressed on the necessity of legal necropsy for various infantile asphyxia cases, in the speculation of the cause of death, in order to not only study infantile sudden death cause but also not to mis-diagnose genuine accidental asphyxia cases or homicidal cases using suffocation for Sudden Infant Death Syndrome (SIDS).

Key words infant death, SIDS, histology, pathology, conjunctivae petechial hemorrhage, asphyxia

Introduction

The differential diagnosis of legal autopsy cases of infantile asphyxia is very difficult, including the so called “Sudden Infant Death Syndrome” (SIDS), mainly because of the issue of whether the death was caused by genuine accident or careless mistake or homicide or genuine diseases. In the past, only parents and grandparents had taken care of infants, but now many other people are involved in taking care of infants, for example babysitters and kinder garden teachers. So the question of the responsibility for death of infants has become increasingly important. Many complicated cases of infantile sudden death have been brought to trial.

This report presents the findings of the examination of 85 infantile asphyxia cases in which the infant died under
various circumstances. We have examined the autopsy findings and histological findings, in connection with conjunctivae petechial hemorrhage that is one of the most important signs suggesting asphyxia, especially, asphyxia by strangulation and manual strangulation. Additionally, we studied the lungs and the pancreas in detail. The examination of the lungs may give information, concerning the hemodynamics in the cases studied. Pancreatic islet cell hyperplasia or nesidioblastosis has been reported in some SIDS cases, suggesting that abnormal B-cell proliferation could be related to the cause of sudden death (Polak and Wigglesworth, 1976; Polak et al. 1978; Hisaoka et al. 1992).

**Materials and Methods**

In this report, the 85 cases selected for study could be divided into 2 groups. 1) 30 cases divided into 2 subgroups 1-a): 4 cases of accidental death by cervical pressure. 1-b): 26 cases of accidental suffocation, some being suspected cases of SIDS. 2) 55 cases of homicide divided into 3 subgroups. 2-a) 18 cases of death by strangulation. 2-b) 18 cases of manual strangulation. 2-c) 19 cases of homicide by suffocation.

All cases occurred over a span of 20 years, from 1976 through 1996, and involved infants of age less than 3 years (mean age about 8 months). All tissue specimens and related documents were stored in Saga Medical School. In each case, data concerning the victim's age and sex, as well as the circumstances of death are reported (Table 1). The data concerning the distribution and degree of the conjunctivae petechial hemorrhages, petechial hemorrhage in other organs, together with the findings of inspection of the neck skin and of other parts of the body are reported in Table 2.

| TABLE 1. Summary of the cases reported in this study and of the circumstances of death |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| category                        | accidental cases (n=30) | homicidal cases (n=55) |
| age                            | 1~3 years (80%), <1 year | 1~3 years ≤1 year       | 1~3 years ≤1 year       | ≤8 months ≤1 year                      |
| sex                            | ♂♂ | ♂♂ | ♂♂ | ♂♂ | ♂♂ |
| season                         | all seasons | all seasons | all seasons | all seasons | all seasons |
| time                           | day time (90%) | night time (70%) | night time | all times | all times |
| location                       | home or playground | home or nursery | home | home | home or nursery |
| inspection diagnosis           | some asphyxia | not clear (sometimes SIDS) | some asphyxia | probably some asphyxia | not clear (sometimes SIDS) |
| cause of asphyxia              | with ropes | prone position or cloth, mattress | stockings belts ropes | hands and nails | with hand or with some cloth or thick quilt |
TABLE 2.
Summary of findings obtained by external inspection

<table>
<thead>
<tr>
<th></th>
<th>accidental cases (n=30)</th>
<th>homicidal cases (n=55)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>subgroup 1-a (4)</td>
<td>subgroup 1-b (26)</td>
</tr>
<tr>
<td></td>
<td>subgroup 2-a (18)</td>
<td>subgroup 2-b (18)</td>
</tr>
<tr>
<td></td>
<td>subgroup 2-c (19)</td>
<td></td>
</tr>
<tr>
<td>congestion of the face</td>
<td>+++ ~ ++</td>
<td>+++ ~ ++</td>
</tr>
<tr>
<td></td>
<td>~ ±</td>
<td>~ ±</td>
</tr>
<tr>
<td>blood filling of the face</td>
<td>+++ ~ ++</td>
<td>+++ ~ ++</td>
</tr>
<tr>
<td></td>
<td>~ ±</td>
<td>~ ±</td>
</tr>
<tr>
<td>in adult cases (sometimes Θ)</td>
<td>&lt; in adult cases</td>
<td>&lt; in adult cases</td>
</tr>
<tr>
<td>conjunctivae petechial hemorrhage</td>
<td>+++ ~ ++</td>
<td>+++ ~ ++</td>
</tr>
<tr>
<td></td>
<td>~ ±</td>
<td>~ ±</td>
</tr>
<tr>
<td>in adult cases (sometimes Θ)</td>
<td>&lt; in adult cases</td>
<td>&lt; in adult cases</td>
</tr>
<tr>
<td>tongue protrusion</td>
<td>++ ~ +</td>
<td>++ ~ +</td>
</tr>
<tr>
<td></td>
<td>~ ± ~ ±</td>
<td>~ ± ~ ±</td>
</tr>
<tr>
<td>neck, abrasion and marks</td>
<td>++ ~ +</td>
<td>++ ~ +</td>
</tr>
<tr>
<td></td>
<td>~ or the lips</td>
<td>~ or the lips</td>
</tr>
<tr>
<td></td>
<td>the tongue slight</td>
<td>the tongue slight</td>
</tr>
<tr>
<td></td>
<td>abrasion</td>
<td>abrasion</td>
</tr>
<tr>
<td>nail cyanosis</td>
<td>++ ~ +</td>
<td>++ ~ +</td>
</tr>
<tr>
<td></td>
<td>~ ± ~ ±</td>
<td>~ ± ~ ±</td>
</tr>
<tr>
<td>defecation</td>
<td>+ ~ ±</td>
<td>~ ± ~ ±</td>
</tr>
<tr>
<td></td>
<td>~ ± ~ ±</td>
<td>~ ± ~ ±</td>
</tr>
</tbody>
</table>

Histological sections of lungs and pancreas tissue were examined. The tissue was fixed in buffered 10% formalin and embedded in paraffin. Four-micrometer-thick sections were deparaffinized and stained with hematoxylin-eosin (HE). Histochemical staining was carried out with periodic acid-Schiff (PAS) for neutral mucins, alcian blue for acidic mucins, and the PAP immunohistochemical staining using anti-α1-chymotrypsin and the factor VIII (DACO, USA), for detecting specific macrophages and the VIII factor being demonstrated positive in some endothelial cells.

Results

The findings in the subgroup 1-a are shown in Tables 1 and 2. Death in this group occurred while the child was playing alone or with other children. There was no malicious intent. While playing with ropes or neckties, the neck of the infant was compressed and this caused death. Almost all cases showed congestion of the face, blood filling of the conjunctivae of the eye lid and eye ball, conjunctivae petechial hemorrhages of the eye, protrusion of the tongue, the abrasions and marks on the skin of the neck, cyanosis of the nail beds and defecation (Table 2). The petechial conjunctivae hemorrhage was always present shown in some spots to large marks. Autopsy and histological findings of the lung and the pancreas are shown in Tables 3 and 4 and Figs 1 and 2. In the lung, venous and capillary congestion and bleeding were found. In the pancreas, there were some edematous lesions and some proliferation.
**TABLE 3.**

*Histological findings in the lungs*

<table>
<thead>
<tr>
<th></th>
<th>subgroup 1-a</th>
<th>subgroup 1-b</th>
<th>subgroup 2-a</th>
<th>subgroup 2-b</th>
<th>subgroup 2-c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary edema</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
</tr>
<tr>
<td>Congestion</td>
<td>++</td>
<td>++ ~ ±</td>
<td>++</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
</tr>
<tr>
<td>Alveolar hemorrhage</td>
<td>+</td>
<td>++ ~ ±</td>
<td>+</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
</tr>
<tr>
<td>Emphysema</td>
<td>+ ~ ±</td>
<td>+++ ~ ±</td>
<td>+</td>
<td>+ ~ ±</td>
<td>+++ ~ ±</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>+ ~ ±</td>
<td>+++ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+++ ~ ±</td>
</tr>
</tbody>
</table>

**Fig. 1.** Histological section of lung from case of subgroup 1-a, showing moderate congestion and hemorrhage. (×100, H. E.)

**TABLE 4.**

*Histological findings in the pancreas*

<table>
<thead>
<tr>
<th></th>
<th>subgroup 1-a</th>
<th>subgroup 1-b</th>
<th>subgroup 2-a</th>
<th>subgroup 2-b</th>
<th>subgroup 2-c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acinar cells</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
</tr>
<tr>
<td>and interstitial</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
</tr>
<tr>
<td>tissues</td>
<td>±</td>
<td>± ~ ±</td>
<td>±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
</tr>
<tr>
<td>Congestion</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
<td>± ~ ±</td>
</tr>
<tr>
<td>Langerhans islets</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Edema</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
<td>++ ~ ±</td>
</tr>
<tr>
<td>Congestion</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
<td>+ ~ ±</td>
</tr>
<tr>
<td>Cell infiltration</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**Fig. 2.** Histological section of pancreas from case of subgroup 1-a, showing edematous lesions without congestion. (×200, H. E.)
PETECHIAL HEMORRHAGE IN INFANTILE ASPHYXIA

Fig. 3. Histological section of lung of a case from the suffocation group, demonstrating emphysema and atelectasis. (×100, H. E.)

Fig. 4. Photograph of the eye from a case of strangulation, showing scarce conjunctivae petechial hemorrhages.

Fig. 5. Histological section of pancreas from a case of subgroup 2-a, showing only edematous lesions with some cell infiltration. (×200, H. E.)

ings were similar, but the lung tissue, in some cases, showed remarkable atelectasis and some emphysema (shown in Fig. 3). In some cases, moderate cell infiltration, including lymphocytes, was demonstrated.

In the subgroup 2-a, the findings were similar to those in subgroup 1-a, as described in Tables 2-4, and Figs 4 and 5. In the subgroup 2-b, the intensity of the findings was less than in the subgroup 2-a (Tables 2-4). In the subgroup 2-c, the findings were similar to those obtained in the subgroup 1-b, (Tables 2-4). The results show that in the majority of the suffocation cases, regardless of sex, many samples did not demonstrate congestion in the pancreas, and a few of the reactive macrophages were immunoreactive to α1-chymo-trypsin. Concerning immunoreactivity for VIII factor or mucinous stainings, no difference was demonstrated between these subgroups.

Discussion

The main objectives of forensic
necropsy are to ascertain the cause of
death and estimate the time of death. So,
in legal autopsy cases, definite inspec-
tion and examination of various organs
have been necessary, especially, the
diagnosis of “so-called infant sudden
death” cases. In this report, we exam-
ined 85 cases of infantile asphyxia,
including SIDS cases, suspected severe
abuse cases and other homicide cases.
In most cases the victims were younger
than one year. In the cases of homicide,
this was by suffocation with pillows,
mattresses or cloth, without using some
ligatures and hands. Putting the baby’s
face violently to the big pillow and cloth,
mattress often had caused very easily
the infantile death. On the other hand,
really, many cases were of accidental
genuine mechanical asphyxia. Fur-
thermore, probably, in our experience,
the infants younger than 3-year old could
not try suicide. So, in almost cases, we,
in the legal medicine office, might be
able to exclude pure suicide, but we
have to consider always that the death
was related or not to the some behaviors
of the parents.

The asphyxia cases were carefully
discussed in many previous papers and
some important reports referred to the
conjunctivae petechial hemorrhages.
Additionally the histological findings in
the lung have been reported. (Garrow
and Werne, 1953; Bergman et al. 1969;
Naeye, 1974; Polak and Wigglesworth,
1976; Polak et al. 1978; Marie, 1986;
Rintanaka and Hirvonen, 1986;
Norvenius, 1987; Rajs and Hammarquist,
1988; Naeye, 1990; Hisaoka et al. 1992;
Valdes-Dapena, 1992; Valdes-Dapena et
al. 1993). Besides, in adult cases, on
many occasions, the circumstances of
the death and external appearances of
the body are evident, if not conclusive,
which had suggested the cause of death
as mechanical asphyxia. In this report,
we examined 85 cases of infantile
asphyxia cases and the examination
of these cases revealed four main
points. First, infantile asphyxia cases
demonstrated, in most cases, very few
conjunctivae petechial hemorrhages.
The presence of conjunctivae petechial
hemorrhages have been considered a
characteristic of death due to mechan-
ical asphyxia. These hemorrhages suggest
compression of the veins in the neck,
causing engorgement upstream of the
compression. However, in this study,
conjunctivae petechial hemorrhage was
scarce, even in the cases of strangula-
tion, and definitely less frequent than in
adult asphyxia cases. Furthermore, in
the cases of strangulation and manual
strangulation, abrasions as well as nail
marks and subcutaneous hemorrhages
were sometimes very infrequent. Second,
infantile suffocation cases showed,
regardless of whether the death was
accidental or homicidal, many similar-
ities in the findings of inspection and in
the histological findings.

Third, in most cases the degree of
congestion of the lungs was not marked,
and the pancreatic tissue demonstrated
only edematous parenchyma and inter-
stitial tissue, as well as some cell infil-
tration without finding of congestion. In
adult cases of asphyxia, remarkable
congestion and venous engorgement
were found in both the lungs and the
pancreas. So, it might be suggested that
in the infantile cases, the stress of the
sudden strong pressure applied to the
neck caused quickly cardiac arrest,
before sufficient blood had time to accumulate in the veins upstream of the neck compression. Four, we found some hyperplasia findings of islet cells in many accidental and homicidal infantile autopsy cases.

In criminal cases, the role of injury in the cause of death is a very important problem, especially in the cases in which parents are the principal accused. However, it is not always easy to clarify the causal sequence between death and injuries. Our results suggest that for diagnosing the cases of asphyxia by suffocation in infants, careful examination of two conditions is helpful: i) the sleeping posture and ii) the blood flow dynamics. The both mechanism is very difficult to demonstrate but we should study it from wide sides, physically and histochemically. With further investigations, including more careful post-mortem examination and the histology, more and more information and report samplings will be necessary in the future. All of those deaths should be subjected to the same thorough investigation that necessary to ascertain the cause when it is obscure.

So we would like to stress some results, especially distribution and number of conjunctivae petechial hemorrhage and histological pancreatic findings, including immunohistochemically. Generally speaking, the mechanism of the death cause of asphyxia has been not elucidated. However, in fact, many infants have been miserable victims by homicidal suffocation. So, we have to carefully diagnose and inspect the infantile victims, in order not to misdiagnose “genuine” SIDS to asphyxia or “pure accident,” uncontrollable accident to some homicide.

References


