Considerable discrepancies are found in the text-books of anatomy, as to what pass through the foramen and notch located at the supraorbital margin of the frontal bone. According to most text-books, the lateral branch (N. supraorbitalis BNA) of the supraorbital nerve passes through the supraorbital foramen (or notch), and the medial branch (R. frontalis BNA) through the frontal notch (or foramen). But as demonstrated by many who investigated the skull, the frontal notch is very often missing. What course then does the medial branch take? According to many English-written and some German text-books, in which the frontal notch (or foramen) is completely neglected, the supraorbital nerve goes through the supraorbital notch (or foramen) and then splits into its terminal branches (Gray's Anatomy, Gebenbaur's Text-book etc.). Moreover, some authors mention the supratrochlear notch (or foramen), for the transmission of the nerve bearing the same nomenclature.

As to the vessels, the agreement is complete in the description that the supraorbital foramen (notch) transmits the supraorbital artery and vein. The frontal notch, when not neglected, is generally considered as the passage solely for the nerve. However, according to most of Japanese and many German text-books, the supratrochlear vessels (A. frontalis and V. frontalis BNA) should pass through the frontal notch. This must be, of course, erroneous since these vessels run under the tendon of the obliquus bulbi superior muscle and have no relation to the supraorbital margin.

To clarify the true disposition of these nerves and vessels, we investigated 39 head-halves of the Japanese cadavers from our dissecting room. The superficial branches of the nerves and vessels were dissected at first, and then according to the schedule of the
dissection exercise, the orbit was opened from its upper wall and the intraorbital part of the nerves and vessels were followed up to the orbital margin. The dissections were done by ourselves, with some exceptions, where the student had already worked on them to some extent.

**Observations**

*Ligaments of the supraorbital and frontal notches.*

When the supraorbital notch (I_{2+} or I_1 of the authors, see below) occurred, there was found always a more or less marked transverse ligament at its mouth. This is sometimes designated as supraorbital ligament. The frontal notch (I_2 of the authors, see below), if present, had also a similar ligament, much weaker than the supraorbital. By these ligaments, we could also define whether the vessels, passing the orbital margin together with the nerves, run through the notch or pass outside of it, as in the case of the foramen.

Table 1. The passage of the supratrochlear nerve (N_3).

<table>
<thead>
<tr>
<th>Passage of N_3</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without foramen or notch</td>
<td>35</td>
</tr>
<tr>
<td>Through a notch</td>
<td>1</td>
</tr>
<tr>
<td>Through a foramen</td>
<td>2*</td>
</tr>
<tr>
<td>The nerve missing</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>

* In one of the cases, N_2 + N_3 entered a common osseous canal, which opened into two foramina (see text).

*Supratrochlear nerve (N_3)*.

The supratrochlear nerve arose normally, i.e. from the frontal nerve, in the majority of the cases (34/39). In four cases, it branched out in the orbit from the medial branch of the supraorbital nerve, with a separate passage at the supraorbital margin. It was completely missing in one case, in which the medial branch of the supraorbital appeared to compensate it.

It is interesting to note that the nerve passed through a foramen or a notch in a few cases (Table 1). Besides, in one of these cases, a common trunk of the supratrochlear nerve and the medial branch of the supraorbital entered an osseous canal, which opened into two separate foramina, transmitting the two nerves respectively.
Supraorbital Nerve and Vessels and their Notches (Foramina)

Fig. 1. No. 23 (right side), with I1+2.
The supraorbital artery splits into three twigs (A1). Two of them passing through the notch and one in company with Ns, they anastomose with the supratrochlear artery (A2), which is developed more than usual.

Fig. 2. No. 33 (left side), with I1+2.
The supraorbital artery and vein accompany N1-N2, but both run outside the notch. N2 is a twig of the medial branch.

Abbreviations used in figs. 1-5.

N1: lateral branch of the supraorbital
N2: medial branch nerve
N3: supratrochlear nerve
N4: infratrochlear nerve
A1 and V1: supraorbital artery and vein
A2: supratrochlear artery
V2: communicating vein (so-called nasofrontal vein) connecting the superior ophthalmic and the angular veins

Medial (N4) and lateral (N1) branches of the supraorbital nerve (Table 2).

In the present cases, these two branches passed more often through a common notch or foramen at the supraorbital margin (22/39), before they assumed their own courses (Figs. 1 and 2).

The common passage for N1-N2 was more or less large. Generally it appeared as a notch, which was always more or less deep. As the two branches were generally being formed before reaching the supraorbital margin, they could be recognized separately in the common passage. In two cases an osseous process incompletely divided the notch in two parts.

In 17 cases the medial and the lateral branches took quite separate courses (Figs. 3 and 4). The lateral branch (N1) passed through far more often a foramen, but sometimes the passage appeared as a deep notch. The medial branch, on the contrary, made
Table 2. The passages of the medial (N₂) and the lateral (N₁) branches of the supraorbital nerve.

<table>
<thead>
<tr>
<th>Passage at the supraorbital margin</th>
<th>Foramen</th>
<th>Notch</th>
<th>?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common for N₁+N₂</td>
<td>3</td>
<td>19</td>
<td>–</td>
<td>22</td>
</tr>
<tr>
<td>Separate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for N₁</td>
<td>12</td>
<td>4</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>for N₂</td>
<td>4</td>
<td>13</td>
<td>–</td>
<td>19</td>
</tr>
</tbody>
</table>

?: Not recorded in our note by a hazard mistake.

more often a notch at the supraorbital margin. The notch (our L₂) was generally shallow, but could be readily recognized by its prominent lateral edge, the medial edge, however, being often wanting.

Supraorbital artery (Table 3).

The supraorbital artery passed the supraorbital margin more often in company with N₁+N₂, which penetrated the common passage, but sometimes with N₁ or N₂, in rare cases even with N₃. In four

---

Fig. 3. No. 36 (left side), with F₁ and I₂.

The supraorbital artery (A₁) passes through I₂. The supraorbital vein (V₁) also accompanies N₂, but passes outside the notch.

Fig. 4. No. 5 (left side), with F₁ and F₂.

The supraorbital artery (A₁) passes through F₂, while the supraorbital vein (V₁) through F₁. In this case, the socalled nasofrontal vein (V₂) runs in company with the supratrochlear nerve (N₄).
Fig. 5. No. 24 (right side), with $F_1$ and $I_2$. The supraorbital artery is completely missing and replaced by branches of the supratrochlear artery ($A_2$). The veins are not examined.

Table 3. The passage of the supraorbital artery (39 cases) and vein (28 cases).

<table>
<thead>
<tr>
<th>Nerve accompanied</th>
<th>Course at the supraorbital margin</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Through the notch or foramen</td>
<td>Outside the notch or foramen</td>
</tr>
<tr>
<td>$N_1 + N_2$</td>
<td>7 (5)</td>
<td>11 (9)</td>
</tr>
<tr>
<td>$N_1$</td>
<td>4 (5)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>$N_2$</td>
<td>6 (1)</td>
<td>0 (1)</td>
</tr>
<tr>
<td>$[N_1, N_2]_1$</td>
<td>2 (1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>$[N_1 + N_2]_0$</td>
<td>1 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>$N_3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The artery or the vein missing$^b$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: The numbers concerned with the vein are presented in parentheses.
1) The artery or vein splitted into two branches, which ran with $N_1$ and $N_2$ respectively.
2) The artery splitted into two branches, running with $N_1 + N_2$ and $N_3$ respectively.
3) In this case $N_3$ had neither notch nor foramen.
4) The superficial part of the supraorbital vein was present in all the cases. But in these four cases it did not flow into the orbit.
cases the artery was missing (Fig. 5), and the supratrochlear artery sent branches to the supraorbital region. In seven cases the artery was small, and joined to the supratrochlear artery, which was developed in its place (Fig. 1).

It is very interesting to note that in not a few cases the artery did not penetrate, but ran outside the foramen or notch, through which passed the accompanying nerve (Fig. 2). Moreover, when the vessels ran together with $N_1 + N_2$, intrainsisural (intraforaminal) course was rather rare.

Supraorbital vein (Table 3, in parentheses).

The supraorbital vein was investigated in 28 cases. As shown in the table, its relations to the nerves and foramen or notch were almost the same as that of the artery. However, the artery and the vein did not always take the same course. In three cases they took quite different courses (Fig. 4); in five cases one of them penetrated the foramen or notch and the other passed outsides (Fig. 3).

Position of the notch and foramen for $N_1$ and $N_2$.

The distance from the trochlear fossa* to the center of the notch and foramen was measured in 23 cases (10 with separate passages and 13 with common passage). As seen in the diagram (Fig. 6a), when $N_1 + N_2$ pass through a common passage, it is apt to lie in the intermediate region between the notches and/or foramina for $N_1$ and $N_2$ in the cases with two separate passages. However, the position of the common passages is fairly variable; some of them lie far laterally and the diagram shows somewhat bimodal character. In order to obtain further information concerning this, we examined 32 orbits from 17 macerated Japanese skulls. Of course, in the case of macerated skulls, it is impossible to distinguish what nerve passes through a foramen or a notch. But, as will be discussed later, we can assume, without any serious error, a single foramen or notch as the passage for $N_1 + N_2$ and double foramina and/or notches for $N_1$ and $N_2$ respectively. In these materials, besides the distance from the trochlear fossa, the one from the median plane was also measured (Figs. 6b, c). As the results, the general pattern of the

* The distance from the median plane appears to be a more appropriate criterion. However, as the materials we examined had already been divided in two head-halves, we could not perform accurate measurements from the median plane.
diagram was very similar to that of the foregoing measurements. Tendency of a bimodal distribution was also suggested.

Fig. 6. Position of the supraorbital and frontal notches and foramina.

a) the common passage (13 cases) for \( \text{N}_1+\text{N}_2 \): hatched
the separate passages (10 cases) for \( \text{N}_1 \): blank
for \( \text{N}_2 \): solid

b) and c) macerated skulls (32 orbits)
with single notch or foramen, assumably for \( \text{N}_1+\text{N}_2 \) (17 cases): hatched
with two notches and/or foramina (15 cases)
lateral, assumably for \( \text{N}_1 \): blank
medial, assumably for \( \text{N}_2 \): solid
The most important result of the present investigation is that in a considerable number of the cases, the supraorbital artery and the supraorbital vein pass outside the foramen or the notch of the supraorbital margin, while the main branches of the nerves pass through them without exception. Only some filaments chiefly distributed to the palpebra run outsides. Furthermore, no notch or foramen is found to be exclusively for the transmission of the vessels. These facts clearly mean that the foramina or notches of the supraorbital margin represent essentially the passages for the nerves, and that the vessels may or may not utilize them. Thus, we can classify them according to what nerves pass through them. Namely:

\[ I_{1,2} \text{ or } F_{1,2} : \text{the supraorbital notch or foramen, common for } N_1 \text{ and } N_2; \]
\[ F_1 \text{ or } I_1 : \text{the lateral supraorbital foramen or notch for } N_1; \]
\[ I_2 \text{ or } F_2 : \text{the medial supraorbital notch or foramen for } N_2; \]
\[ I_3 \text{ or } F_3 : \text{the supratrochlear notch or foramen for } N_3, \text{ rare occurrence.} \]

The occurrence of them is listed in Table 4. In consonant with these designations, we will call the above-mentioned ligaments as: the supraorbital (\( I_{1,2} \)), lateral supraorbital (\( I_1 \)) and medial supraorbital (\( I_2 \)) ligaments.

These foramina and/or notches are named in BNA and PNA Foramen sive Incisura supraorbitalis and Incisura sive Foramen frontale. These two terms are widely adopted, although the latter is neglected.

<table>
<thead>
<tr>
<th>Table 4. Notches and foramina found at the supraorbital margin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>With one notch or foramen</td>
</tr>
<tr>
<td>( I_{1,2} )</td>
</tr>
<tr>
<td>( F_{1,2} )</td>
</tr>
<tr>
<td>With two notches and/or foramina</td>
</tr>
<tr>
<td>( F_1 ) \quad ( I_2 )</td>
</tr>
<tr>
<td>( F_2 ) \quad ( F_3 )</td>
</tr>
<tr>
<td>( I_1 ) \quad ( F_2 )</td>
</tr>
<tr>
<td>( I_1 ) \quad ( I_2 )</td>
</tr>
<tr>
<td>( I_{1,2} ) \quad ( I_3 )</td>
</tr>
<tr>
<td>( F_{1,2} ) \quad ( F_3 )</td>
</tr>
<tr>
<td>With three notches and/or foramina</td>
</tr>
<tr>
<td>( ?_1 ) \quad ( F_2 ) \quad ( F_3 )</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>10*</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>In one of the 10 cases ( N_3 ) was missing.</td>
</tr>
</tbody>
</table>

* In one of the 10 cases \( N_3 \) was missing.
in not a few text-books (especially those written in English). Of them the supraorbital foramen or notch would really correspond to our F₁₁,2 and F₁₁ or I₁₁, and the frontal notch or foramen to our I₁ or F₁.

In this regard the description of Lockhart et al., that the supraorbital notch (foramen) transmits the supraorbital nerve or its lateral branch, is more accurate, although they neglect the occurrence of the frontal notch or foramen. Some authors (Bardeleben and Hollinshead) describe that the supraorbital notch or foramen, for the transmission of the supraorbital nerve, sometimes occurs in double. According to them, the notches and foramina other than the supratrochlear are all "supraorbital".

According to previous works[1,2,3,4], the occurrence of the supraorbital notch and foramen is about 60% and 40% in orbits of the Japanese skulls. Our study also yielded the results similar to theirs (Table 2): out of 38 cases, I₁₁,2 and I₁ are found in 23 (60.5%) and F₁₁,2 and F₁ in 15 (39.5%). However, it must be emphasized that the common passage for the N₁ + N₂ generally appears as a notch, and the separate passage for the N₁ appears rarely as a notch. This condition has not been known previously, and is attributable to the thickness of the piercing nerve.

The frontal foramen (our F₂) occurred in 4 out of 39 cases.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Orbits investigated</th>
<th>With notch</th>
<th>With foramen</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray's Anatomy</td>
<td>——</td>
<td>ca 50%</td>
<td>——</td>
<td>ca 50%</td>
</tr>
<tr>
<td>Zweibach</td>
<td>2142</td>
<td>1012 (47.6%)</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>Adachi</td>
<td>242</td>
<td>6 (2.5%)</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>Akabori</td>
<td>824</td>
<td>149 (18.1%)</td>
<td>25 (3.0%)</td>
<td>650 (78.9%)</td>
</tr>
<tr>
<td>Kameda</td>
<td>228</td>
<td>——</td>
<td>6 (2.6%)</td>
<td>——</td>
</tr>
<tr>
<td>Kato and Outi (Nerves examined)</td>
<td>39</td>
<td>13 (33%)</td>
<td>4 (10%)</td>
<td>22 (56%)</td>
</tr>
<tr>
<td>Kato and Outi (Macerated skulls)</td>
<td>32</td>
<td>12 (38%)</td>
<td>3 (9%)</td>
<td>17 (53%)</td>
</tr>
</tbody>
</table>

Remark: Besides, Ono reported a very frequent occurrence of the frontal notch (including indistinct ones), but his table 100–1 contains incomprehensible errors, according to which we cannot estimate the true number of its occurrence.
(10%), a higher number than that by the previous workers. The occurrence of the frontal notch (our \( I_1 \)) is variably reported as shown in Table 5. As discussed already, the frontal foramen or notch is the passage for the medial branch of the supraorbital nerve. Therefore, it should be absent, when the supraorbital nerve passes the supraorbital margin as a single nerve or its terminal branches, closely associated, go through a single passage. This fact, however, was not recognized by the previous investigators of the macerated skull. This would be the cause of the discrepancy about the occurrence of the frontal notch; some would have tried to find even the faintest notches, and some would have confined their calculation to rather conspicuous ones, considering that any clear-cut distinction could not be made on a very faint notch. Our observations show that the frontal notch (\( I_1 \)) has always a prominent lateral edge, and that we cannot fail to recognize it, if present. An indistinct or vestigial frontal notch would be a kind of imaginary structure, at best a rare condition.

In our materials, the common passage for \( N_1+N_2 \) (i.e. without the frontal notch or foramen) was found in 22 out of the 39 cases (56%), and the separate passages for \( N_1 \) and \( N_2 \) in 17 cases (44%). According to Ito the supraorbital nerve, without bifurcating, reached the supraorbital margin in 75 out of 100 cases (53 cases with and 22 without the supraorbital foramen) and in two cases it splitted in the orbit into two terminal branches, which, however, passed through a common foramen. As he mentioned nothing about the presence or the absence of the supraorbital notch, his figures cannot be compared directly with ours. But the occurrence of the common passages is higher than our observations. From our and Ito's results, it is concluded that the presence of the common passage for \( N_1+N_2 \) and the absence of the frontal notch or foramen (\( I_1 \) or

Table 6. Occurrence of the supraorbital and frontal notches and/or foramina in 32 orbits of macerated skulls.

<table>
<thead>
<tr>
<th></th>
<th>Foramen</th>
<th>Notch</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>With one notch or foramen</td>
<td>4</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>With two notches and/or foramina</td>
<td>lateral 11</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>medial 3</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>
Table 6 illustrates the occurrence of the notches and foramina in the macerated skulls which we used for the foregoing measurements. In all respects, the results are almost the same as in Table 2.

The notch (I₃) and foramen (F₃) for the supratrochlear nerve were found in one and two cases respectively (9% in total). But we suppose them to be rather rare variations, because in the cases of the macerated skull we could not find any. They are mentioned by Sieglbauer*, Lockhart et al. and Hollinshead as rare structures, but are reported by no investigators of the macerated skulls, presumably being calculated in the frontal notch or foramen.

The supraorbital artery and vein are generally considered as passing through the supraorbital notch or foramen (i.e. in company with N₁ + N₂ or N₁). But our results show that in some cases they may run together with the medial branch of the supraorbital nerve (N₂), in rare instances even with the supratrochlear nerve. Moreover, as already discussed, they pass outside the notch or foramen in a considerable number of the cases.

The communications between the orbital and facial veins are also described diversely. In this report we call that vein as the supraorbital, which arises from the frontal veins, passing the supraorbital margin, flows into the orbit, runs over the tendon of the obliquus superior muscle and behind it drains into the superior ophthalmic vein. Another communicating vein (so-called nasofrontal vein, V₂ in the figures) connecting the angular vein to the origin of the superior ophthalmic, runs under the pulley, in company with the so-called nasotrontal artery (K a n s a k u).

Our measurements showed that the common passage is apt to lie between the separate passages. This fact may offer some criterion to distinguish the foramina and notches of the macerated skulls. But their position was very variable. The diagram of the position of the common passages even showed a somewhat bimodal distribution (its significance is not known from the present study). Moreover, in some cases I₁ (F₁) and I₂ (F₂) were found far medially

* Sieglbauer described the supratrochlear notch as the passage for the nerve and vessels bearing the same name. As to the vessels his opinion would be erroneous.
or laterally and closely near each other. For example, in one case
$I_1: 8.7 \text{ mm and } I_2: 11.0 \text{ mm from the trochlear fossa};$ in another case
$F_1: 15.6 \text{ mm and } F_2: 20.8 \text{ mm}$. In such cases, if the materials are
macerated and the decision is solely made from their position, one
might take them for two frontal notches or two supraorbital foramina.
Thus, the position is of little use for the distinction of the
notches and foramina. In this regard, however, the number of
the passages serves as a useful criterion. As seen from Table 4,
all the single notches or foramina were passages for $N_1 + N_2$, with-
out exception; no plural passages for the lateral or the medial
branch were found in the present study, and such are considered
very rare variations at best. $I_1$ or $F_1$ occurred in a few cases, but
it can be distinguished by its far medial position. Therefore, there
is no danger of making a serious error in assuming a single notch
or foramen as the common passage and double ones as the separate
passages.

Summary

Thirty-nine head-halves of the Japanese cadavers from our
dissecting room were investigated. Results obtained are as follows:
1. The so-called supraorbital and frontal notches have a transverse
ligament at their mouth. By this, one can distinguish whether the
nerves and the vessels running together, pass inside or outside the
notches, as in the case where the passage is a foramen.
2. The nerve takes always the inside course while in a considerable
number of the cases the vessels running together with the nerve
pass outside the foramen or notch (Table 3).
3. Therefore, the so-called supraorbital and frontal foramina and
notches are essentially the passages for the nerves. We could dis-
tinguish the following foramina and notches:
   a) supraorbital notch ($I_{n}, 19/38$) and foramen ($F_{n}, 3/39$), common
      for the lateral and medial branches of the supraorbital nerve
      PNA;
   b) lateral supraorbital foramen ($F_{l}, 12/39$) and notch ($I_{l}, 4/39$),
      for the lateral branch ($N_{l}$) of the supraorbital :
   c) medial supraorbital notch ($I_{m}, 13/39$) and foramen ($F_{m}, 4/39$),
      for the medial branch ($N_{m}$); and
   d) supratrochlear foramen ($F_{t}, 2, 38$) and notch ($I_{t}, 1/38$), for the
      supratrochlear nerve ($N_{t}$).
4. In about one half of the cases there was found only one notch or foramen for the supraorbital nerve. In the cases of two notches and/or foramina, they did not always represent the respective passages for the lateral and the medial branches of the supraorbital; they were sometimes for the supraorbital and supratrochlear nerves respectively. In one case three separate passages for the lateral and medial branches and the supratrochlear nerve were found. (Table 4).

5. The supraorbital artery and vein run generally together with the supraorbital nerve or its lateral branch, but sometimes it may run in company with the medial branch, in a rare instance even with the supratrochlear nerve.

6. The position of these foramina and notches were examined (Fig. 6). The common passage for the supraorbital nerve (I, or F,) is apt to lie in the intermediate region between the separate passages for N, and N,. The distribution diagram of I, and F, is suggestive of a bimodal distribution, the significance of which, however, is unknown.

Literature


Following text-books of systematic and regional anatomy were also referred to:
Japanese: Osawa, Okajima, Mori-Hirazawa-Ogawa-Mori, Kaneko;
German: Henles Handbuch, Rauber-Kopsch, Spalteholz, Braus, Benninghoff, Schultz-Lubosch, Hafferl, Pernkopf;
British and American: Morris, Cunningham, Gardner-Gray-O’Rahilly, Callander's Surgical Anatomy, Grant's Method of Anatomy;
French: Sappey, Poirier.