SOME ASPECTS OF SKULL BASE SURGERY

Carl A. Hamberger, M.D. (Karolinska Institute, Sweeden)

In recent years the whole field of skull base surgery formerly a no man's land has come increasingly into the foreground. Otolaryngologists have long hesitated in the presence of tumors in this region. Neurosurgeons have considered as inoperable all tumors originating above the paranasal sinuses and extending into them.

Many specialists, for example ophthalmologists, always send their patients with peribulbar tumors to the neurosurgeons. Instead of a transcranial operation, with often severe postoperative complications, an otolaryngologist can in many cases do an exploration through the maxillary antrum, ethmoid or sphenoid sinus. I am therefore convinced that ophthalmologists and otolaryngologists together have to solve these problems.

It would take too long to discuss here all questions of current interest. I would like instead to take up such problems that I have dealt with in the past years, often in consultation with neurosurgeons, neuroradiologists and ophthalmologists.

When it comes for example to skull base fractures with communication to the ear or the paranasal sinuses, neurosurgeons and otolaryngologists are nowadays in complete agreement.

Liquorrhea, which is a common complication of skull base fractures, is treated in most cases by the neurosurgeon. It must however be pointed out that the otolaryngologist has a better possibility of getting good results than the neurosurgeon, if the defect in the dura is located in the area of the sphenoid sinus. In this kind of injury we can get very satisfactory results after exploration of the roof of the sphenoid sinus and insertion of a graft of muscle or fascia.

When I now touch upon the paranasal sinuses, it is reasonable to stop for a moment at malignant tumors in this region with infiltration of the dura. Earlier, we very often considered these cases as inoperable.

Sometimes in tumors with a low grade of differentiation we can get good results, or at any rate some palliative effect with irradiation. In other cases we always try to resect the affected part of the dura and cover the defect with a full-skin graft.

There are two regions of the skull base in which I have been especially interested, namely the area of the jugular foramen and, since many years, the area of the sphenoid sinus.

At our clinic we have for many years been specially interested in the whole area of the skull base.

We usually divide the approaches to the skull base into three types. The first is through the ear, in various diseases of the inner ear, such as an acoustic tumor and Meniere's disease. The second approach is made from the neck along the vessel sheath, in tumors that may extend from the ear towards the jugular foramen, as well as tumors that are primary in this region. The third or medial approach must be used in diseases involving the paranasal sinuses. I am thinking more particularly of processes extending along the roof of the sphenoid sinus, for example chromophobe adenoma or acromegaly.

Before continuing I should like to illustrate with some slides the type of material we are dealing with when using the different approaches. In the medial, we have the material on this slide. You see acromegaly, chromophobe adenoma and various other tumors. As regards the lateral approach, we have a number of parapharyngeal, often neurogenic tumors. Tumors around the jugular foramen also belong to this group. Glomus jugulare tumors of the ear often extend into the jugular foramen. The region with which I am particularly concerned today is, precisely, the area of the jugular foramen, when treatment requires an approach from the neck.
The term jugular syndrome otherwise known as Vernet's syndrome denotes the group of symptoms arising from paralysis of all the cranial nerves that pass through the jugular foramen. The tumors or other growths that exert pressure on the nerves, and thus cause the paralysis, may be intra or extracranial or situated in the foramen itself. With the growing interest among neck surgeons in operative treatment for tumors around the skull base, new methods for diagnosing these conditions have been introduced.

The medial anterior part of the jugular foramen, which is known as the pars nervosa, transmits the IXth, Xth and XIth cerebral nerves and the anterior petrosal sinus. The right jugular foramen is usually larger than the left.

The internal jugular vein begins as a funnel-shaped dilatation, the superior bulb, in the posterior compartment of the jugular foramen.

The glossopharyngeal nerve passes through the anterior compartment of the jugular foramen, lateral and anterior to the vagus and the accessory spinal nerves.

It is rare for only one of the nerves passing through the jugular foramen to be damaged. A number of different syndromes have been described in which different groups of the last four cranial nerves are involved.

The symptoms resulting from damage to the glossopharyngeal nerve include impairment of the sensitivity of the posterior third of the tongue, the tonsils and the pharynx, and of the sense of taste in the affected posterior part of the tongue. The salivary secretion is also affected. The condition is diagnosed by tests of the taste and pharyngeal reflex. Sialometry may also give some information.

Isolated damage to the vagus nerve in the posterior cranial fossa is rare, the aforementioned nerves usually also being involved. The cause generally lies in a tumor, in most cases a glomus tumor-a tumor in the middle ear from the glomus jugulare described by Guild. These so-called paraganglia are small richly vascularized and innervated bodies in the adventitia of the bulb of the jugular vein along the tympanic nerve.

The hypoglossal nerve is often damaged with the aforementioned cranial nerves.

Involvement of the spinal accessory nerve results in paralysis of the sternocleidomastoid and trapezius muscles.

In retrograde jugularography—the method for phlebography of the internal jugular vein used at Karolinska Sjukhuset at the Ear, Nose and Throat Clinic since 1959—the internal jugular vein is punctured percutaneously on the neck between the sternal and clavicular heads of the sternocleidomastoid muscle, best into the inferior jugular bulb. Puncture is performed percutaneously under local anesthesia, and the vein is most easily located by getting the patient to strain. A polythene catheter is inserted by Seldinger's method through the needle, and advanced as far as the superior bulb. Contrast medium (Urografin 20–30–40%) is then injected in the retrograde direction, under the highest possible manual pressure, or by means of a syringe driven with compressed air. During the injection, the vein cardial to the site of puncture is compressed. Directly after injection, four to five films are exposed in rapid succession (2 exposures/sec), usually in the frontal and lateral projection. Some of the contrast medium then passes across the sigmoid sinus on the opposite side, and both transverse sinuses and jugular veins can be visualized. This method provides an excellent picture of the jugular bulb, the sigmoid and transverse sinuses, as well as other sinus formation of the skull.

Retrograde jugularography has, above all, been a very good aid in diagnosing tumors in and around the jugular foramen. In all cases with the jugular syndrome and other types of nerve symptoms from this area, we also do arterial angiograms, special tomography of the jugular foramen and encephalography if necessary.

After this brief survey—focused mainly on the jugular foramen—I will show various examples of tumors of the skull base that it has been possible to diagnose with different roentgenologic methods, in particular jugularography and arteriography. A char-
acteristic feature of all the examples I am about to show is that the patients had neuro-otologic symptoms. Here one can, in fact, speak of extended neuro-otologic diagnosis, which includes functional disturbances of a large number of cranial nerves.

**Cases I-VI.**

To sum up this survey of pictures I would like to stress that in a large number of conditions with cranial nerve symptoms, one can envisage diseases within the ear, nose and throat region, where a localized diagnosis can be reached only with the aid of jugularography and arteriography. When the lesions have been localized, complementary puncture biopsy will provide the final diagnosis. In my opinion, all this diagnosis and first and foremost naturally the question of treatment — is a problem for oto-rhinolaryngology. With greater knowledge of numerous tumor states which often are benign we will be increasingly often faced with this type of disease, and be obliged to explore different parts of the skull base from below. One must consistently bear in mind that when it is a question of intracranial processes, a neuro-surgical intervention is required. On the other hand, a transcranial operation should not be undertaken in a single case in which there is a possibility of reaching the pathologic process extracranially — via the ear, the neck or the paranasal sinuses.

Now I would like to say a few words about the treatment of this type of tumor. The glomus jugulare tumor is generally benign. The tumor is not very radiosensitive and a complete disappearance of the tumor without recurrence after irradiation therapy is rare. The best method is of course a complete exploration of the whole area. If the tumor has invaded the jugular bulb, the operation must include complete simple or radical mastoidectomy and exploration of the jugular bulb under careful dissection of the jugular vein, the facial nerve, the spinal accessory nerve, the glosso-pharyngeal, hypoglossal and vagus nerves. The sigmoid sinus must be exposed and packed, the jugular vein ligated, and the tumor thrombus extracted, as well as the tumor of the middle ear.

The second part of my presentation today will deal with the **region of the sella turcica.**

To provide a background for my experience of this kind of surgery I would like to show a table of our case material: It demonstrates that during the first years: 1954—1958, we mainly removed the normal gland in patients with different types of endocrinologic diseases. Nowadays we operate upon many types of tumors in this area, which you can see from this picture.

In my opinion it is forbidden to open this region without having full information about the anatomy. First we must know the pneumatization of the sphenoid sinus. We classify the sphenoid sinuses into three main groups — namely, conchal, presellar and sellar types.

The **conchal** type of sphenoid sinus does not reach into the body of the sphenoid bone.

The **presellar** type of sphenoid sinus is easily located on the X-ray picture. The anterior wall of the sella turcica does not bulge into the sphenoid sinus.

The sellar type of sphenoid sinus is so deep that the anterior wall of the sella turcica is, on the average, only half an millimeter thick.

The sellar type of sphenoid sinus is most common. Both the presellar and the sellar type may occur in the same patient. In our series, both sphenoid sinuses were of the pressellar type in 11 percent and of the conchal type in 3 per cent.

The thickness of the anterior wall of the sella turcica is important — the thinner the wall, the easier is the initial break-through to the pituitary.

Other factors to be borne in mind in transsphenoidal interventions are variations in the position of the intersphenoidal septum. These can best be recognized on radiograms in the axial projection.

**Operative technique**

The first step is a maxillary sinus operation according to Denker, and the second step involves exposure of the sella turcica and enucleation of the pituitary gland or tumor.

After ethmoidectomy, the anterior wall of the sphenoid sinus is displayed. As a rule, the two ope-
nings of the sinus are easily visible. It can be seen how the mucosa wells out of the orifice. The anterior wall of the sphenoid sinus can be punched out through the openings. The thickness of the wall varies greatly. In some cases it is only as thick as parchment, and in others a few millimeters thick; this applies especially to the midline.

The bulge of the internal carotid artery often protrudes on both sides, but presents no great difficulties, since the vessel can be discerned in most cases through the usually thin bone. When the anterior wall of the sella has been definitely localized, removal of the bone is started. A thin chisel is used first. A lid about the size of a pea is made, and lifted off with a small hook. When the greyish, glistening capsule of the hypophysis or the tumor then becomes visible, an elevator inserted between it and the corticalis interna permits easy orientation. The whole anterior wall can then be removed without any difficulty with a punch.

After exposure of the capsule, thin veins can be seen to run on both sides between the cavernous sinus. There is generally one such venous communication in the upper margin, and one in the lower. Exact localization of these veins is of importance for the later procedure.

To understand how the capsule must be opened, it is important to be acquainted with the layers of its wall, which distinctly shows, underneath the bond, an outer periosteal layer, an intermediate vascular layer in which the venous communications between the two cavernous sinuses run – and a thin, fibrous layer directly over the gland itself.

After thorough cleansing of the operative cavity, a vertical and a horizontal incision are made through the capsule with a fine knife or diathermy knife. It is important to start the former incision in an area devoid of veins, and then to widen the opening in the direction of the cavernous sinus. A small curved knife is used, when – after the first incision – the capsule has been freed from the actual glandular tissue with a small dura hook. Through the cruciate incision thus formed, the hypophysis bulges increasingly forwards. The flaps of the capsule are turned outwards, so that the anterior wall of the gland or the tumor is displayed to a successively greater extent. At this point, there may be moderate bleeding from the internal aspect of the capsule, but it can be arrested by very slight pressure.

Dissection is then continued with an elevator between the capsule and the gland. As a rule, there is no difficulty in rotating out the gland. However, in some cases it seems to be adherent to the capsule, particularly at the sides. The gland is pressed downwards, so that the stalk becomes visible and stretched. This may be associated with slight leakage of spinal fluid. The pituitary stalk usually ruptures when the pressure on the gland is gently increased from above with the dissector. When the stalk has ruptured, the hypophysis wells out. A few millimeters of the stalk generally follow the main preparation.

Moreover, when there is a leakage of spinal fluid, it usually ceases when the stalk has ruptured. The stump of the stalk seems, in fact, to plug the hole in the diaphragma sellae. The empty cavity is filled with a small piece of muscle, taken from the anterior aspect of the thigh. The cavity is then plugged with gauze, which is removed successively between the 5th and 8th postoperative days.

After this demonstration, I would like to say some words about acromegaly and chromophobe adenomas, the two most common diseases that may be discussed here.

Acromegaly is a disease which, untreated, leads to significant disability and shortening of life expectancy through intracranial extension of the tumor, diabetes mellitus, hypermetabolism, splanchnomegaly, and, ultimately, heart failure.

It is a polysymptomatic disease and may be associated with adenomas of the adrenals, thyroid or parathyroid as well as with hypertrophy of the lymphatic apparatus, hyperplasia of the submandibular gland, adenoma of the parotid gland and peptic ulcer disease. Hemorrhoids and/or varices and hernia are frequently observed.

Generally speaking the objectives of treatment in
acromegaly are:

1) Relief from local pressure symptoms on adjacent structures.

2) Relief from symptoms and signs caused by the overproduction of STH.

3) Relief from secondary (target-organ) hormonal signs and symptoms.

The ideal indication for transsphenoidal operation is a pituitary adenoma that is expanding inferiorly causing enlargement of the floor of the sella turcica. The sellar adenomas may have large suprasellar extensions but for the most part are lying medial to the internal carotid arteries and cavernous sinuses. In our series suprasellar extension of the tumor was found in 29% of the patients, and in 61% of these the suprasellar portion affected the floor of the third ventricle to some extent.

Contraindications to the transsphenoidal operation is a suprasellar mass with a normal sella turcica. In addition the hour-glass formed tumors must be treated by the combined transsphenoidal and intracranial approach, the more is this the case with parasellar adenomas extending laterally.

Visual field defects had been noted in 22 patients in a material of 80 patients. A complete restitution within 14 days after operation occurred in 46% and at the last follow-up 64% of the visual field defects had been normalized and further 14% showed improvement.

Postoperative sellar reconstitution occurred in 64% of the patients.

Total regression of the dominating symptoms - increased perspiration, paresthesias, headache and joint pain occurred in around 74% of the patients, and total regression of the soft tissue swelling was seen in approximately one-third of the patients. No regression of the skeletal changes or lasting reduction in body weight, blood pressure or relative heart volume occurred.

Altogether total regression or improvement was seen in around 94% of the patients.

Normalization of the sexual disturbances after operation was seen in at least one-third of the patients, and it was also proved that acromegalic patients may have normal pregnancies after operation. Improvement of preoperative psychic disturbances was noted in most patients.

Endocrine insufficiencies occurring postoperatively in patients with normal function preoperatively were observed in 14%. The regression of acromegalic symptoms was somewhat more pronounced in patients with endocrine insufficiencies appearing postoperatively, which would speak in favour of total hypophysectomy. However, when increased surgical risks may be expected to accompany total hypophysectomy, this should be avoided since the results were favorable also in patients with normal pituitary function postoperatively.

In the tumor group 80 cases of chromophobe adenoma have been operated on. All cases have been discussed with the neurosurgeons beforehand. The main contraindication to a transsphenoidal approach to these tumors has been considerable parasellar extension. Tumors with moderate suprasellar extension can, however, be removed from below with good results.

Without going into details, I would like to illustrate the potentialities of the transsphenoidal method, by giving some data.

Our series contains six cases of craniopharyngioma. It is worth mentioning that the first patient we operated on through the sphenoid sinus had a craniopharyngioma, for which the neurosurgeons had regarded a transcranial procedure as being too extensive.

We have also tried hypophysectomy in cases of Cushing's syndrome. Our experience here is limited to 18 patients.

We have done hypophysectomy in 30 cases of diabetes mellitus with severe retinal changes. In such cases the results have been better.

We mean that the transantrosphenoidal approach should be borne in mind when a pituitary tumor is present. In many cases it is unquestionably the method of choice and in certain cases may even be the only possible one.