ORIGINAL ARTICLE

Extension of Intracranial Thrombosis After Unilateral Dissection of the Internal Jugular Vein

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Objective: Resection of the internal jugular vein can be necessary in cases of radical neck dissection or even in cases involving benign neoplasms such as glomus tumors. According to the triad described by Virchow (ie, stasis of blood flow, damage to the endothelium, and changes in hemostasis), the development of a thrombosis in the venous vessels superior to the resected internal jugular vein seems to be possible. The aim of this study was to determine the extension of possible intracranial thrombosis after wound healing.

Design: A total of 17 patients requiring resection of the internal jugular vein were evaluated prospectively using magnetic resonance imaging and 2-dimensional (time-of-flight) magnetic resonance angiography after the surgical treatment. Preoperative magnetic resonance images were obtained in all 17 patients for staging purposes as well as to exclude preoperative thrombosis of the internal jugular vein. Sixteen patients had malignant tumors, and 1 patient had a glomus tumor.

Results: Intracranial thrombosis with thrombosis of the sigmoid sinus was found in 4 patients, and thrombosis of the transverse sinus was found in 3 patients. There were no complications such as intracranial hemorrhage or signs of increased intracranial pressure in any patients. There was no evidence of intracranial thrombosis in 10 cases. In these cases, thrombosis of the venous vessels superior to the resected vein ranged from none to complete thrombosis of the superior bulb of the internal jugular vein. After unilateral resection of the internal jugular vein, the venous blood leaves the brain mainly via the venous network of the contralateral side of the neck.

Conclusions: Although intracranial thrombosis of the sigmoid or transverse sinus seems to occur more frequently than was previously thought, intracranial complications such as venous infarction or increased intracranial pressure appear to be very rare. After unilateral radical neck dissection, the venous blood leaves the brain mainly via the venous system of the other side of the neck and the ipsilateral collateral veins.

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RESECTION OF THE INTERnal jugular vein can be necessary in cases of radical neck dissection or even in cases involving benign neoplasms such as glomus tumors. According to the triad described by Virchow (ie, stasis of blood flow, damage to the endothelium, and changes in hemostasis), the development of a thrombosis in the venous vessels superior to the resected internal jugular vein seems to be possible.

Cases of increased intracranial pressure, blindness, convulsions, or death after bilateral radical neck dissection with resection of the internal jugular vein have been reported in the literature.[1-6] There are even fewer reports of cerebral complications occurring after unilateral radical neck dissections than after bilateral radical neck dissections. To our knowledge, only 2 cases of sinus thrombosis occurring after radical neck dissection are documented in the literature (1 involving transverse sinus thrombosis and 1 involving lateral sinus thrombosis),[7,8] and increased intracranial pressure as a complication of unilateral neck dissection has been reported in only 1 case with congenital absence of the transverse sinus.[9] In children, a 1-sided ligation of the internal jugular vein can cause hemodynamic disorders as well as disorders in cerebrospinal fluid circulation, which can lead to increased intracranial pressure, but will not influence the functional status of the brain.[10]

There are only a few case reports on the development of a thrombosis of intracranial veins after resection of internal jugu-

lar vein. The aim of the present study was to determine the extension of possible thrombosis of the jugular bulb, sigmoid sinus, or transverse sinus after resection of the internal jugular vein following wound healing.

METHODS

Magnetic resonance (MR) imaging and 2-dimensional (time-of-flight) MR angiography were used to prospectively investigate 17 cases in which resection of the internal jugular vein was required after radical neck dissection and postoperative radiotherapy (14 of 16 patients) with a superconductive (1.5-T) magnet (Siemens Vision, Erlangen, Germany). Magnetic resonance angiography was performed 1 to 79 months after surgery to demonstrate whether intracranial thrombosis developed after wound healing. The basic principle of time-of-flight angiography involves a slice transition phenomenon, which occurs whenever the blood volume is replaced in its majority by freshly entering spins (blood) during 1 basic imaging sequence. This phenomenon causes a high intravascular signal and allows calculation of MR projection angiograms (maximum intensity projection). When the incoming signal of the arteries is completely saturated, a venous angiogram results. Noninvasive MR angiography has proved to be a reliable imaging modality in studies of the greater arteries and veins of the head and neck and is highly accurate in its ability to detect venous disease.[11-13] Preoperative MR images were obtained in all 17 patients for staging purposes as well as to exclude preoperative thrombosis of the internal jugular vein.

All 17 patients (1 woman and 16 men) underwent a unilateral resection of the internal jugular vein. The average age of the patients was 62 years (age range, 47-70 years). The resection of the internal jugular vein was performed 11 times on the left side and 6 times on the right side. The primary tumor was located in the tonsils in 3 patients, in the tongue in 3 patients, in the hypopharynx in 2 patients, and in the larynx in 3 patients. In 1 patient, the primary tumor was located in the palate. Four patients had metastasis in the neck from cancer(s) of unknown primary origin. One of the 4 patients had metastasis of a malignant melanoma; no postoperative radiotherapy was performed in this case. All other patients mentioned above had squamous cell carcinoma. One patient required resection of the internal jugular vein as a result of a jugular glomus tumor of the internal jugular vein; no postoperative radiotherapy was performed in this case. Preoperative radiation therapy was not performed in any case.

RESULTS

Postoperative images were available for a total of 17 patients who underwent resection of the internal jugular vein; 15 of the 17 patients underwent adjunctive postoperative radiotherapy. In 2 patients, no relevant thrombosis was seen after resection of the internal jugular vein (**Figure 1**). In these patients, the vein was resected approximately 1 cm inferior to the skull base. In 2 patients, thrombosis that extended up to the inferior part of the superior bulb of the internal jugular vein was evident. In 1 patient, there was partial thrombosis of the bulb. Total occlusion of the bulb was detected in 5 patients. Among the 10 patients with no intracranial thrombosis, resection of the internal jugular vein was performed 7 times on the left side and 3 times on the right side. Intracranial thrombosis with partial thrombosis of the sigmoid sinus was detected in 2 patients. Complete thrombosis of the sigmoid sinus was also seen in 2 patients. Thrombosis of the transverse sinus was found in 3 patients (**Figure 2**). Of the 7 patients with intracranial thrombosis, 4 underwent resection of the internal jugular vein on the left side and 3 on the right side. There were no complications such as intracranial hemorrhage or signs of increased intracranial pressure in any patients.

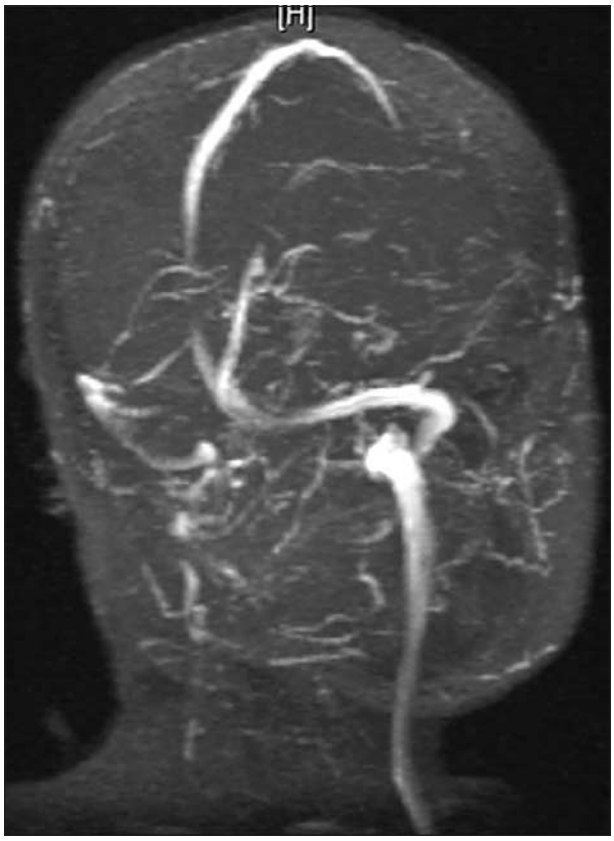

Figure 1. Resection of the internal jugular vein on the right side: No intracranial thrombosis but reduced flow on the right side compared with the left side.

Two-dimensional MR angiography showed that venous drainage of the head after unilateral resection of the internal jugular vein took place mostly on the contralateral side of the neck. In 1 patient, there was hypoplasia of the internal jugular vein on the contralateral side, with thrombosis of the sigmoid sinus and the tranverse sinus, so that the blood left the brain via strong bilateral collateral veins, especially nuchal veins and spinal veins. In 9 of 17 patients, venous, as well as contralateral, drainage was carried out via ipsilateral nuchal and spinal veins.

COMMENT

Thrombosis of the intracranial sinuses is possible in pediatric cases of infections, especially of the middle ear or of unknown origin. It is well known that this type of thrombosis can lead to intracranial complications, with resulting venous infarction. In children, a 1-sided ligation of the internal jugular vein can cause hemodynamic disorders as well as disorders in cerebrospinal fluid

Figure 2. Resection of the internal jugular vein of the left side: Thrombosis of the sigmoid and transverse sinuses.

circulation, which can lead to increased intracranial pressure, but does not influence the functional status of the brain.[10] Also, in adults, complications such as thrombosis of the sigmoid sinus with intracerebral complications are well known in cases of cholesteatoma or acute otitis media. There have been a few reports of increased intracranial pressure, blindness, convulsions, or death in cases involving bilateral radical neck dissection with resection of the internal jugular vein.[1-6] To our knowledge, there has been only 1 report of transverse sinus thrombosis and 1 of lateral sinus thrombosis after radical neck dissection.[7,8] In contrast, intracranial complications after 1-sided unilateral radical neck dissection with resection of the internal jugular vein seem to be extremely rare. Increased intracranial pressure as a complication of unilateral neck dissection was reported in only 1 case with congenital absence of the transverse sinus.[9]

As far as we know, no study has been performed to date concerning the extension of the possible thrombosis of intracranial vessels after resection of 1 internal jugular vein. To detect the incidence and extension of this type of thrombosis in the present study, noninvasive MR angiography was used. This technique has proved to be a reliable modality in imaging studies of the greater arteries and veins of the head and neck, providing a high accuracy in the detection of venous disease.

In our study, 17 patients were examined after resection of 1 internal jugular vein as part of their treatment for malignant or benign tumors. No intracranial thrombosis was observed in 10 cases. In these cases, thrombosis of the venous vessels superior to the resected vein ranged from none to complete thrombosis of the superior bulb of the internal jugular vein, and resection of the internal jugular vein was performed 7 times on the left side and 3 times on the right side. Intracranial thrombosis with thrombosis of the sigmoid sinus and/or the transverse sinus was detected in a total of 7 patients, which means that there was intracranial thrombosis in approximately 40% of the patients who underwent unilateral resection of the internal jugular vein. In these 7 patients, resection of the internal jugular vein was performed 4 times on the left side and 3 times on the right side, and 3 of the 7 patients had thrombosis of the transverse sinus. We found only 2 cases of transverse sinus thrombosis after unilateral radical neck dissection in the literature. Since we also found 2 cases of transverse sinus thrombosis in our 17 patients, it must be expected that thrombosis of the transverse sinus is more common than was previously thought, even in cases involving unilateral resection of the internal jugular vein. In these 2 cases, the radical neck dissection was performed on the right side in one patient and on the left side in the other patient. No signs of increased intracranial pressure or venous infarction were seen in any patient. Also, the lack of clinical reports regarding complications due to internal jugular vein ligation suggests that the observed intracranial thromboses are of little clinical importance.

Contrary to our findings, intracranial complications due to thromboses caused by infection seem to occur more frequently. This increase in complications may result from bacterial damage to the vascular endothelium. Transcellular penetration, eg, transcytosis across the blood-brain barrier, has been demonstrated for several bacteria. Evidence suggests that microbial proteins are the major genetic determinants mediating penetration across the blood-brain barrier. Fungal, viral, and parasitic pathogens may follow similar mechanisms.[14-16]

Venous drainage of the head involves a complex and variable network. The blood leaves the brain mainly via the internal jugular veins but also via the emissary veins and the occipital, orbital, pterygoid, and pharyngeal plexus. There is a communication between an intracranial and an extracranial venous system through the emissary and diploic veins. In our patients, venous drainage after unilateral resection of the internal jugular vein was mostly carried out via the venous network on the contralateral side of the neck. In 9 of 17 patients, dilated nuchal and spinal veins were detected after surgery and the venous blood flowed mainly via these collateral veins, the veins of the opposite side, and the occipital plexus.

As described before, the blood leaves the brain mostly via the internal jugular veins. Durgun et al[17] angiographically evaluated the lateral dominance of the dural venous sinus in 206 cases. They found that in 2.1% of cases the drainage is limited only to the right side, and in 0.5% of cases only to the left side. Several independent studies have shown that the right lateral sinus and jugular foramen appeared to be larger than the left lateral sinus and jugular foramen in the majority of cases.[18] It could therefore be possible to expect more extensive intracranial thrombosis after resection of the right side. In our study, there was no correlation between the resected side of the internal jugular vein and extension of intracranial thrombosis.

CONCLUSIONS

Intracranial thrombosis caused by infections often leads to intracranial venous infarction. Contrary to these infectious causes of intracranial thrombosis, intracranial complications such as venous infarction or increased intracranial pressure seem to be very rare after unilateral radical neck dissection. Intracranial thromboses occur after unilateral radical neck dissection in approximately 40% of cases. Therefore, intracranial thrombosis of the sigmoid sinus or the transverse sinus seems to be more common than was previously thought. Neurologic deficits caused by these thromboses have not been found. After resection of the internal jugular vein, dilated nuchal and spinal veins, and sometimes dilated occipital veins, can be found. The internal jugular vein on the opposite side is usually dilated compared with the preoperative size. After unilateral radical neck dissection, the venous blood leaves the brain mainly via the venous system of the other side of the neck and the ipsilateral collateral veins.

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