Surgical Experience of Paraclinoidal Aneurysms

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= Abstract =

상상돌기 주위 동맥류의 수술적 치험

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Objective Paraclinoidal aneurysms termed that aneurysms arising from proximal internal carotid artery(ICA) between the site of emergence of the carotid artery from roof of the cavernous sinus and origin of the posterior communicating artery(PCoA). These aneurysms pose conceptual and technical surgical problems with regard to acquisition of proximal control and safe intracranial exposure. The efficiency of surgical technique according to the location of paraclinoidal aneurysm was studied for minimal exposure.

Materials and Methods Over the past four years, the authors treated surgically 171 cases of cerebral aneurysm, among them ten patients were paraclinoidal aneurysms with two patients unruptured aneurysms. Mean age was 47 years old, and all patients were female. Three patients were proximal posterior carotid artery wall aneurysms(one large, one giant), four patients carotid-ophthalmic artery aneurysms and three patients superior hypophyseal artery aneurysms.

Results There could be done clip in all cases, there were no deaths and no complication. And no patient developed sustained neurological deficits including visual function except hydrocephalus in one case.

Four patients complained of visual disturbance but two patients had recovery after postoperation and two patient were not longer to bad.

Conclusion Our recent experience suggests that preoperative scrutiny of diagnostic angiography allows classification of all paraclinoidal aneurysms regardless of size and surgical technique which this classification has focused on operative approaches unique to each aneurysm projection was helpful to improve the operative outcome with good visual function and to shorten the operative time.

KEY WORDS Aneurysm· Paraclinoidal aneurysm· Carotid-ophthalmic artery aneurysm· Superior hypophyseal artery aneurysm· Proximal posterior carotid artery aneurysm.

Introduction

Aneurysms arising from the internal carotid artery(ICA) between the site of the carotid artery from the roof of the cavernous sinus and the origin of the posterior communication artery(P-com) have traditionally been termed “ophthalmic artery aneurysms” since the ophthalmic artery is the chief vessel arising from this segment. It is clear, however, that aneurysms arising from this portion of the carotid artery are heterogeneous in terms of origin, projection and relationship to the bone and dura of the skull base. So, all aneurysms around anterior clinoid process will be referred to as “paraclinoidal” carotid artery aneurysms. Paraclinoidal aneurysms have a well-known association with multiplicity and bilaterality, particularly in women. These aneurysms are reasonably uncommon and account for approximately 1.3% to 5.0% of documented intracranial aneurysms. These aneurysms will be classified into three types of practical grouping carotid-ophthalmic artery aneurysms with a superior or superomedial projection superior hypophyseal aneurysms with a medial or inferomedial
projection and proximal posterior carotid artery wall aneurysms projecting posteriorly or posterolaterally.

This admittedly arbitrary grouping has allowed a very practical means of designing a specific surgical approach for the individual patient in order to accomplish the key objectives in treating paraclinoidal aneurysms 1) establishment proximal artery control, 2) adequate exposure of the proximal neck, often with focused resection of portions of the anterior clinoid process, 3) aneurysm decompression in large aneurysms by the use of temporary artery occlusion, and 4) successful aneurysm obliteration with minimal manipulation of the optic nerve. These aneurysms pose conceptual and technical surgical problems with regard to acquisition of proximal control and safe intracranial exposure.

Despite the fact that paraclinoidal aneurysms often disobe the traditional teachings of aneurysm development, having no vessel of origin or clear hemodynamic cause, this relative unfamiliarity coupled with the complex relationship of the aneurysm and parent vessels to the cavernous sinus, skull base, and optic nerves has produced uncertainty and controversy over the optimum means of safe and effective exposure. The purpose of this paper was not to detail the pertinent neurovascular and skull-base anatomy, but rather to study a straightforward and anatomically based surgical techniques resulting from a high-volume exposure to minimal exposure.

Materials and Methods

1. Patient population

Between 1995 and 1999, 10 cases of paraclinoidal aneurysms among 171 cases which were surgically undergone by authors were treated.

Mean age was 47 years old, mean fisher grade was 1.89 mean and H-H grade was 2.22. The aneurysms were classified by the site of origin and projection into three categories 1) carotid-ophthalmic aneurysms with superior or superomedial projection arising just distal to the ophthalmic artery, 2) superior hypophyseal aneurysms arising from the medial or inferomedial wall of the carotid artery, 3) proximal posterior carotid artery wall aneurysms arising from the posterior or posteroslateral wall of the carotid artery with no apparent vessel of origin.

The anatomical distribution of the paraclinoidal aneurysms were as follow carotid-ophthalmic artery aneurysm, 4cases superior hypophyseal aneurysm, 3cases proximal posterior carotid artery wall aneurysms, 3cases.

2. Surgical techniques

A 2-to 4-cm section of the ICA in the neck for proximal artery control was exposed and then isolated with a vessel loop. After complete microsurgical dissection of the median sylvian fissure and carotid cistern, distal artery control was obtained immediately proximal to the PCoA origin and a site prepared for distal temporary clipping. After intradural and subarachnoid exposure of the aneurysm was completely performed, a vascular clamp was placed across the cervical ICA and a temporary clip across the supraclinoidal ICA immediately proximal to the PCoA.

For the superior hypophyseal aneurysms the dural aspect of the optic canal falciform ligament was opened with this dural incision and the aneurysm was easily clippable.

Bone resection for the carotid-ophthalmic artery lesions was focused medially at the lateral margin of the optic canal.

For the proximal posterior carotid artery wall aneurysms a high-speed air drill with a diamond burr was then used to resect the medial aspect of the optic canal and the aneurysm was easily clippable.

Each clip was advanced parallel to the carotid artery and applied to the neck of aneurysm until bone contact was made beneath the lateral aspect of the optic canal.

Result

Clinical summaries for all 10 patients and for anatomical aneurysm group are shown in Table 1. Each type of paraclinoidal aneurysms according to projection of aneurysm are presented Fig. 1, 2, 3.
Table 1. Classification of aneurysm patients and clinical characteristics of paraclinoidal aneurysms

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>sex</th>
<th>Location</th>
<th>Size (mm)</th>
<th>Fisher grade/H-H grade</th>
<th>Visual disturbance</th>
<th>Associated aneurysms</th>
<th>EVD</th>
<th>Hydrocephalus</th>
<th>Outcome</th>
</tr>
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<tr>
<td>1</td>
<td>F/47</td>
<td></td>
<td>Rt C.O</td>
<td>15</td>
<td>II/II</td>
<td>-</td>
<td>A-com P-com</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>F/60</td>
<td></td>
<td>Ll C.O</td>
<td>33</td>
<td>I/IV</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
<tr>
<td>3</td>
<td>F/35</td>
<td></td>
<td>Ll C.O</td>
<td>17</td>
<td>II/II</td>
<td>-</td>
<td>P-com</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
<tr>
<td>4</td>
<td>F/66</td>
<td></td>
<td>Rt C.O</td>
<td>8</td>
<td>II/I</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
<tr>
<td>5</td>
<td>F/29</td>
<td></td>
<td>Ll S.H</td>
<td>10</td>
<td>II/II</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
<tr>
<td>6</td>
<td>F/58</td>
<td></td>
<td>Rt S.H</td>
<td>10</td>
<td>II/II</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
<tr>
<td>7</td>
<td>F/77</td>
<td></td>
<td>Ll S.H</td>
<td>25</td>
<td>III/III</td>
<td>-</td>
<td>A-com P-com</td>
<td>+</td>
<td>-</td>
<td>fair</td>
</tr>
<tr>
<td>8</td>
<td>F/51</td>
<td></td>
<td>Ll P.P</td>
<td>15</td>
<td>III/IV</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>fair</td>
</tr>
<tr>
<td>9</td>
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<td></td>
<td>Rt P.P</td>
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<td>II/II</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>10</td>
<td>F/49</td>
<td></td>
<td>Ll P.P</td>
<td>14</td>
<td>II/II</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>good</td>
</tr>
</tbody>
</table>

C.O: carotid-ophthalmic artery  
S.H: superior hypophyseal artery  
P.P: proximal posterior carotid artery  
H-H: Hunt-Hess

Fig. 1. Superior hypophyseal aneurysm. Upper] Preoperative view demonstrating of aneurysm arising from the medial or inferomedial wall of the carotid artery. Lower] Postoperative view indicating successful clipping.
Fig. 2. Carotid-ophthalmic aneurysm. Upper\% Preoperative view demonstrating aneurysm arising from superior or somewhat superomedial projection just distal to the ophthalmic artery. Lower\% Postoperative view indicating successful clipping.

Fig. 3. Proximal posterior carotid artery wall aneurysm. Upper\% Preoperative view demonstrating aneurysm arising from the posterior or posterolateral wall of the carotid artery. Lower\% Postoperative view indicating successful clipping.
In all patients, there were agreed preoperative angiography with operative finding and angiography was helpful to operative procedures.

1. Carotid-ophthalmic artery aneurysm
Two patients had other aneurysm, A-com and P-com. one patient with giant aneurysm had left optic atrophy before operation but mild improved after operation.

2. Superior hypophyseal aneurysm
One patient had other aneurysm, A-com and P-com. the patient was tolerable in two operation in spite of old age.

3. Proximal posterior carotid artery wall aneurysm
One patient had poor medical condition and Hunt-Hess grade was IV. But, the patient was recovered after EVD and finally had been recovered drowsy mentality. The exposure for the giant aneurysm of proximal posterior carotid artery wall aneurysm was good enough to apply the clip (Fig. 4, 5) and aneurysm was well clipped which were identified using by transcranial Doppler during operation and immediate postoperatively. Two days later after operation the patient became drowsy and no flow in transcranial Doppler was found through ipsilateral internal carotid artery. No flow was also identified by postoperative angiography (Fig. 4), which might be resulted from clip slippage causing proximal carotid artery occlusion. But the patient was
recovered without change of initial visual symptoms and returned to her normal life.

4. Treatment outcome

There were done clipped in aneurysm all patients. There were no deaths and no patient developed sustained neurological deficits including visual symptom except one patient who was done L-P shunt for hydrocephalus. All patients returned their normal lives following discharge from the hospital.

Discussion

Paraclinoidal aneurysms pose unique surgical challenges due to their intimate relationship to the skull base and optic nerve.

Carotid-ophthalmic artery aneurysms appear to have a clear relationship to the origin of the ophthalmic artery and usually project superiorly or superomedially\(^2\)^\(^,\)\(^6\)^\(^,\)\(^8\)^\(^,\)\(^10\)\(^,\). For these more typical cases, some degree of bone as well as dura removal is required for definitive isolation of the proximal aneurysmal neck. The key to success in the exposure of these particular aneurysms lies in the complete exposure of the lateral aspect of the optic canal.

Superior hypophyseal aneurysms typically arise from the medial wall of the ICA and expand asymmetrically and inferomedially due to the generous subarachnoid space in the suprasellar region\(^2\)^\(^,\)\(^7\)^\(^,\)\(^10\)^\(^,\)\(^14\). For clipping of the superior hypophyseal aneurysms the dural aspect of the optic canal (falciorm ligament) is opened with this dural incision and the aneurysm is easily clippable.

For clipping of the proximal posterior carotid artery wall aneurysms a high-speed air drill with a diamond burr is then used to resect the medial aspect of the anterior clinoid process and small portion of the posterior orbital roof to maximize the progressive anterior exposure of the lateral optic canal. This focused resection has dual purpose of greater manipulation during final aneurysm dissection. The final bone resection is then performed to uncover widely the lateral aspect of the optic canal. The flap is excised with the falciorm ligament and the distal dural ring of the carotid artery opened. This bone and dural excision exposes a long segment of intracanalicular optic nerve, the ophthalmic artery, and the proximal aneurysmal neck.

This admittedly arbitrary grouping has allowed a very practical means of designing a specific surgical approach for the individual patient in order to accomplish the key objectives in treating paraclinoidal aneurysms.

After proximal artery control has been established in the neck and thorough dissection of the median sylvian fissure and carotid cistern has been accomplished, the falciorm ligament or dural component of the lateral aspect of the optic canal is sectioned with bone resection\(^13\)^\(^,\)\(^14\)^\(^,\)\(^18\). This maneuver is usually performed in the distal to proximal direction and the clip aligned in parallel with the long axis of the carotid artery. The clip blades are advanced until bone contact is made beneath the lateral aspect of the optic canal. As with placement of the fenestrated clip, the blades must advance until contact with bone is noted and must close in parallel with the carotid artery.

Finally, placement of a strong clip across a large or giant paraclinoidal aneurysm frequently fails to adequately close the sac and can result in migration of the clip onto the carotid artery wall, resulting in stenosis or intimal injury.

While clinical data in cerebral tolerance of induced ischemia during temporary artery occlusion is difficult to interpret at best it is likely that in many vascular territories a duration of normothermic ischemia of approximately 15 to 20 minutes is close to the upper limit of tolerance. It is also likely that temporary artery occlusion is much better tolerated in the treatment of paraclinoidal aneurysms since collateral flow is possible via the anterior communicating artery and the PCoA\(^8\)^\(^,\)\(^13\)^\(^,\)\(^15\)^\(^,\)\(^17\). It is possible to gain significant preoperative insight into expected tolerance by performing trial endovascular occlusion especially for the large or giant aneurysm.

Protection of the optic nerve must remain a paramount concern when treating paraclinoidal aneurysms. The nerves are frequently severely attenuated by aneurysm growth and are thus very sensitive to physical manipulation or slight vascular compromise. The threat of visual injury is severe in the carotid-ophthalmic artery aneurysm variant in which distortion of the nerve by the mass is most pronounced and the need for surgical manipulation of the nerve is most frequently. Perhaps the optimum means of minimizing shearing forces applied to the nerve is through opening of the optic canal. When this procedure is performed with dural incision of the falciorm ligament and bone decompression as described above, the likelihood of iatrogenic injury is minimized. It is also important to assure that the aneurysm...
is empty at the time of closure to achieve maximum de-
compression and that surgical clips are not distorting the
optic apparatus\(^{2(3)}\)\(^{10(12)}\).

Key features to determine the degree of dural and bone
resection include the site of origin from the carotid artery,
the projection of the aneurysm, and the displacement of the
distal carotid artery\(^{2(3)}\)\(^{10(12)}\).

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상상돌기 주위 동맥류의 수술적 치험

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목적: Paraclinoidal aneurysm은 일반적으로 청각성 동맥류로 상상돌기 주위 동맥의 증가된 내압에 의해 발생합니다. 수술적 치험은 비교적 드문 경우이기 때문에 본 연구에서는 상상돌기 주위 동맥류의 수술적 치험에 대해 서술합니다.

대상 및 방법: 2001년 1월 1일부터 2001년 12월 31일까지 10개월간 상상돌기 주위 동맥류로 진단된 4명의 환자 중 171명의 환자를 대상으로 하였습니다. 이 중 47명의 환자에서 수술적 치험이 이루어졌으나, 이 중 3명의 환자에서 proximal posterior carotid artery, 4명의 환자에서 carotid-ophthalmic artery, 3명의 환자에서 superior hypophyseal artery로 의뢰되었다.

결과: 수술적 치험의 경우, 수술 후 1주일간의 평균 수술 시간은 4시간 59분이었고, 수술 후 2일간의 평균 병원 입원 기간은 2일이었다. 수술 후 복통이 2명의 환자에게 발생하였다.

결론: 본 연구의 결과, 상상돌기 주위 동맥류의 수술적 치험이 이루어졌으며, 수술 시간과 입원 기간이 적고, 수술 후 복통이 적은 것을 확인하였다. 이는 paraclinoidal aneurysm의 외과적인 치험을 위해 유용한 결과를 제공할 수 있었다.

중심 단어: 상상돌기, 주위 동맥류, 수술적 치험, 치환, 수술 시간, 병원 입원 기간, 수술 후 복통