Role of the Inferior Thyroid Vein after Left Brachiocephalic Vein Division During Aortic Surgery

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Background: In aortic surgery, division and ligation of the left brachiocephalic vein(LBV) may improve exposure of the aortic arch but controversy continues about the safety of this division and whether a divided vein should be reanastomosed after arch replacement was completed. The safety of LBV division and the fate of the left subclavian venous drainage after LBV division were studied. ***Material and Method:*** From November 1998 to January 2001, planned division and ligation of the LBV on the mid-line after median sternotomy was performed in 10 patients during the aortic surgery with the consideration of local anatomy and distal aortic anastomosis. Assessment for upper extremity edema and neurologic symptoms, measurement of venous pressure in the right atrium and left internal jugular vein, and digital subtraction venography(DSV) of the left arm were made postoperatively. ***Result:*** In 10 patients there was improvement in access to the aortic arch for procedures on the ascending aorta or aortic arch. The mean age of patients was 62 years(range 24 to 70). Follow-up ranged from 3 weeks to 13 months. One patient died because of mediastinitis from methicilline-resistant staphylococcus aureus strain. All patients had edema on the left upper extremity, but resolved by the postoperative day 4. No patient had any residual edema or difficulty in using the left upper extremity during the entire follow-up period. No patient had postoperative stroke. Pressure difference between the right atrium and left internal jugular vein was peaked on the immediate postoperative period(mean peak pressure difference = 25mmHg), but gradually decreased, then plated by the postoperative day 4. In all DSV studies left subclavian vein flowed across the midline through the inferior thyroid venous plexus. ***Conclusion:*** We conclude that division of LBV is safe and reanastomosis is not necessary if inferior thyroid vein, which is developed as a main bridge connecting the left subclavian vein with right venous system, is preserved.

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Key words : 1. Aortic arch
2. Aortic aneurysm. arch
3. Brachiocephalic vein

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Introduction

It is a cornerstone of surgery to establish a good exposure and visualization for the meticulous performance of operation. In aortic surgery, excellent proximal and distal exposure is necessary for safe anastomosis. The left brachiocephalic vein is interference in the surgical approach to the distal ascending aorta and aortic arch via median sternotomy. The division of left brachiocephalic vein improves exposure of aortic arch and its great branches but controversy continues about the safety of this division and whether a divided vein should be reanastomosed after arch replacement was completed[1-3].

In particular, concerns have concentrated around impaired venous return from the left arm and the potential consequences of venous hypertension in the arm and brain. Several cases of ligation of LBV after accidental thoracic injury have been reported and some authors have suggested that collaterals through intracranial communications, mammary veins, azygos and hemiazygos system, and mediastinal veins provide venous drainage after division, but planned study for exact course of collaterals and measurement of venous pressure in the left internal jugular vein has not yet been published. Using a digital subtraction venography(DSV) of the left arm and measurement of venous pressure in the left internal jugular vein after divsion of LBV[4-6], this study defines collateral pathway and safety of division and ligation of the LBV to improve exposure of the aortic arch and to facilitate the excision of mediastinal tumors.

Material and Method

From November 1998 to January 2001, planned division and ligation of the LBV on the mid-line after median sternotomy was performed in 10 patients during the aortic surgery with the consideration of local anatomy and distal aortic anastomosis. Venous pressure was monitored from the porximal lumen of 7 Fr. triple lumen catheter placed in the right atrium through the right subclavian vein and the left internal jugular vein with the continuous infusion of heparin solution for fear of cerebral thrombosis. Venous pressure monitoring in the LBV was discontinued after fluctuation was not found over 2 days and catheter was removed. Postoperatively, in relation to this study, DSV was performed at 2 weeks and the assessment was made at 1 month for upper extremity and neurologic symptoms and subsequently at yearly intervals.

All patients had antegrade cerebral perfusion in conjuction with hypothermic circulatory arrest, which we use routienly at our institution. Elevation of the head of the bed was done as soon as possible postoperatively in the intensive care unit to minimize cerebral edema.

Pressure difference between the right atrium and the left internal jugular vein was analyzed using the paired t-test.

Surgical anatomy

From deep to the sternal end of the left clavicle, the left brachiocephalic vein in formed by the confluence of the left internal jugular vein and subclavian veins, and courses obliquely downward and to the right, across the aortic arch and the proximal portions of the arch vessels(brachiocephalic trunck, left common carotid artery, and left subclavian artery), behind the upper half of the manubrium sterni. At the sternal end of the first right costal cartilage, it unites with the right brachiocephalic vein to form the superior vena cava. During it's course, the left brachiocephalic vein receive the superior intercostal veins, the internal mammary veins, the vertebral veins, the inferior thyroid veins, and other smaller tributaries from the thymus and the surrounding structures.

Usually there are at least two, but frequently three or four, inferior thyroid veins that form a plexus anterior to the trachea. From this plexus a left inferior thyroid vein descends and joins the LBV, and right vein pass obliquely downward and to the right across the brachiocephalic artery, and opens into the right brachiocephalic vein, close to its junction with the superior vena cava. In the presence of an expanding aneurysm or dissection of the ascending aorta, cephalad shift of the aortic arch deep to the left brachiocephalic vein may occur.

Surgical technique

After a median sternotomy, the thymic remnant divided, and the pericardium opened, skin incision was extended to the left side of the neck to allow mobilization of the great arteries from the aortic arch with easy. Meticulous clearing of the left brachiocephalic vein was performed with preservation of the inferior thyroid vein and freed for a distance of 2 cm on either side of midline(Fig 1). The LBV was divided between clamps, doubly ligated to ensure absolute hemostasis.

Fig. 1. Divided left brachiocephalic vein improve exposure of the aortic arch and its great branches.

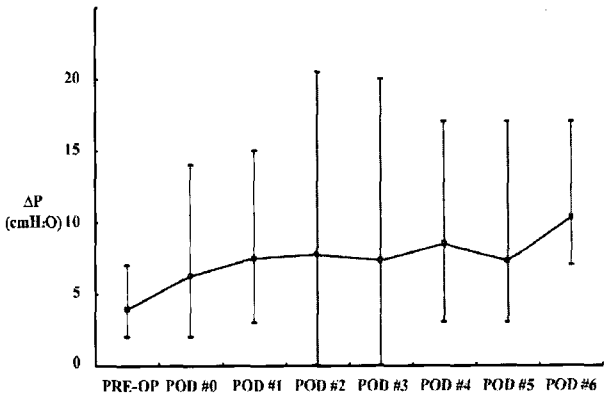

Fig. 2. Post-operative pressure difference between the right atrium and left internal jugular vein: statistically significant peak on the immediate postoperative period (p=0.0198), but gradually decrease, and then plateau by the postoperative day 4 was demonstrated.

Results

The LBV was divided in 10 Koreans who undergone a aortic surgery between November 1998 to January 2001 to improve access to the aortic arch for procedures on the ascending aorta or aortic arch or both. The mean age of the patients, 4 women and 6 men, was 62 years(range 24 to 72) and follow-up ranged from 3 weeks to 13 months. One patient died from mediastinitis due to methicillin-resistant staphylococcus aureus strain after a long period of hospital course. All patients had edema on the left upper extremity, but resolved by the postoperatively day 4. No patient had any residual edema or difficulty in using the leftrupper extremity during the entire follow-up period. All

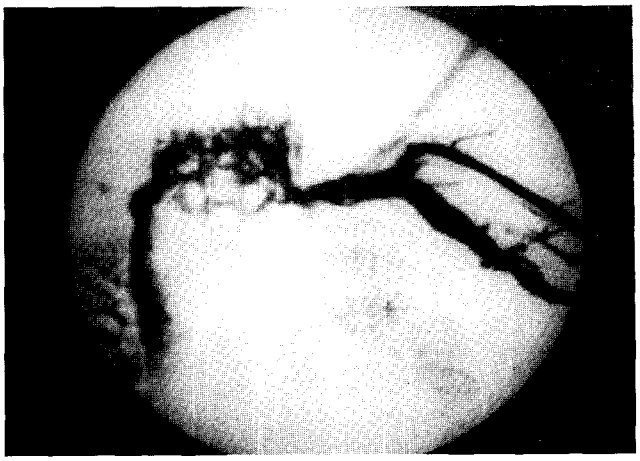

Fig. 3. Post-operative DSV; significant dilated inferior thyroid venous plexus through which left subclavian vein flowed mainly across the midline was demonstrated.

patientst were extubated within the first 24 hours, no patient had postoperative stroke. In addition, non of the patients had any neurologic symptoms. Pressure difference between the right atrium and left internal jugular vein was statistically significantly peaked on the immediate postoperative period(p=0.0198), but gradually decreased, then plated by the postoperative day 4(Fig. 2). Postoperative venous pressure on the left internal jugular vein ranged from 15cmH_2O to 27cmH_2O and there was no venous hypertension. In all DSV studies, significant dilated inferior thyroid venous plexus through which left subclavian vein flowed mainly across the midline was demonstrated and some reversal flows to the sigmoid sinus in the cranium are noted on the left internal jugular vein(Fig 3).

Discussion

The surgical approach to the distal ascending aorta and aortic arch via a median sternotomy can be hindered by the LBV. Division of the LBV provides an excellent exposure of the aortic arch and the proximal portion of the arch vessels. Such exposure facilitates clamping of the head vessels to avoid gaseous and particulate embolization during deep hypothermic circulatory arrest(HCA) as well as selective cerebral perfusion via the head vessels and individual grafting of the head vessels. Surgeons have recognized the advantages of LBV division, but have had uneasiness about the safety of this division because it may be through that the absence of a bridging LBV can lead to venous hypertension of the left upper extremity or an elevation

in intracranial pressure, and the latter would be particularly undesirable when combined with HCA, further exacerbation of postoperative cerebral dysfunction would be likely. For fear of this catastrophic condition, some authors have reanastomoised the vein with autologous or prosthetic graft[7-8]. Lingering concerns have focused to the impaired venous return from the arm and the brain and the potential consequences of venous hypertension in the arm and brain.

On occlusion of the subclavian vein, prolonged edema of the arm may be occured, but on LBV division, it has been suggested that left subclavian venous flow return to the right side of the heart via azygos/hemiazygos systems, the left sigmoid sinus in the cranium, the internal mammary veins, the lateral thoracic and superficial thoracoabdominal veins, and the verterbral venous plexus[4-6]. On the basis of our study we find that inferior thyroid venous plexus, which has not been mentioned and we cannot find any rational explanation why the inferior thyroid vein in all our patients, Koreans, has been developed as major collateral after LBV division. We hope that further studies will prove the reasons.

As for the safety of LBV division, some authors have mentioned clinical experience[2,3] and we have also experienced 20 cases of LBV division safely prior to this study, but there was none to confirm the safety of this division by measuring the venous pressure. In the course of measuring the venous pressure on the left internal jugular vein postoperatively, we have worry about cerebral thrombosis and infused the heparin solution continuously through the right side catheter, which was removed as soon as possible. One patient died due to a mediastinal infection from the methicilline-resistant staphylococcus aureus strain but LBV division did not contribute to her death.

Most aortic surgery can be performed without dividing the LBV. In selected case, however, such division can be technically useful, improving exposure and avoiding traction avulsion of the vein from the superior vena cava.

Conclusion

We conclude that division of LBV is safe and reanastomosis is not necessary if inferior thyroid vein, which is developed as a main bridge connecting the left subclavian vein with right venous system, is preserved.

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=국문초록=

배경: 대동맥 수술에서 왼쪽 팔머리정맥의 분리는 대동맥궁 및 대동맥궁의 가지혈관들을 노출시키는 데 도움을 줄 수 있다. 그러나 이것의 분리에 대한 안정성과 대동맥수술후 다시 왼쪽 팔머리정맥을 문합해 주어야 하는가에 대해서는 논쟁의 여지가 있다. 왼쪽 팔머리정맥 분리의 안전성과 왼쪽 팔머리정맥을 분리한 후 정맥환류에 대해 연구하였다. ***방법:*** 1998년 11월부터 2000년 1월까지 10명의 환자에서 흉골 정중 절개 후 국소적인 해부학과 원위부 대동맥문합을 고려하여 왼쪽 팔머리정맥의 분리 및 결찰을 왼쪽 팔머리정맥의 중앙부에서 시행하였다. 상지의 부종과 신경학적증상에 대해 평가하였고, 우심방압력과 왼속목정맥의 압력을 측정하였으며 수술 후 정맥조영술을 시행하였다. ***결과:*** 10명의 환자에서 상행대동맥이나 대동맥궁의 수술시 대동맥의 노출에 향상이 있었으며, 환자들의 연령은 24~72세로 평균 62세였다. 평균추적기간은 3주에서 13개월이었고, 한명의 환자가 메치실린 저항성 황색포도상구균에 의한 종격동염으로 사망하였다. 모든 환자에서 수술 직후 좌측상지에 부종을 보였으나, 술후 4일째 호전되었다. 추적관찰기간동안 좌측상지에 부종이나 운동장애를 보인 환자는 없었다. 술후 뇌경색에 이환된 환자는 없었다. 우심방과 좌내경정맥 사이의 압력차는 수술직후 최고치를 보였고(평균 최고 압력차=25mmHg), 점점 감소하여 술후 4일째 일정한 압력차를 유지하였다. 모든 환자에서 시행한 정맥조영술을 통하여 왼쇄골밑정맥의 정맥환류는 아래갑상선정맥얼기를 통하여 중앙부를 가로질러 우측 심장계로 유입됨을 볼 수 있었다. ***결론:*** 왼쪽 팔머리정맥의 분리는 안전하며 우측 정맥계의 주된 교량역활을 하는 아래갑상선정맥을 보존한다면 왼쪽 팔머리정맥을 다시 연결할 필요는 없다고 할 수 있겠다.

중심 단어 : 1. 대동맥 수술
2. 왼쪽 무명정맥
3. 아래갑상선정맥