Carotid Endarterectomy in Symptomatic Extracranial Internal Carotid Artery Stenosis: A Result of the First 100 Consecutive Cases in a University Hospital

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Background: *Extracranial carotid artery stenosis has been recognized in 9.2% of ischemic stroke patients by duplex ultrasonography in Thailand. The treatment program of this disease has not been established countrywide.*
Objective: *Carotid endarterectomy in our institute was firstly evaluated for safety and long-term efficiency in order to assess the possibility of expanding this treatment throughout the country.*
Material and Method: *An observational study with long-term follow-up was carried out in 100 consecutive symptomatic patients with severe stenosis (70-99% diameter stenosis) of extracranial internal carotid artery that underwent carotid endarterectomies. All carotid endarterectomies were performed under general anesthesia, with routine use of intravascular shunts during carotid cross clamps and saphenous vein patches for arteriotomy closures. Perioperative mortality and morbidity were evaluated for the safety of this procedure. The long-term stroke-free survival was assessed to announce the efficiency of this treatment.*
Results: *One hundred consecutive patients (68% male and 32%female) with the mean age of 69.9 years were included in the present study. Mean duration of neurological symptoms prior to surgery was 2.5 months. Hemiplegia (64%) was the most common symptom leading to surgery. Hypertension (87%) was the most common comorbidity in the present series. Mean duration of surgical procedure was 210 minutes. Mean durations of total carotid shunting and carotid cross clamp during shunt removal were 75 minutes and 4.5 minutes respectively. Mean length of ICU stay was 1.4 days. The perioperative mortality rate was 1%. The perioperative major stroke rate was also 1%. Ten-year follow-up of the patients revealed no death related to neurovascular event and no evidence of recurrent ipsilateral stroke in the present series. The cumulative 5- and 10-year stroke-free survivals were 86.1% and 73.7% respectively. Duplex ultrasonography in all survivors demonstrated no recurrent stenosis in the affected carotid artery.*
Conclusion: *Carotid endarterectomy with a consistent technique in the present series had a comparable outcome of safety and long-term efficiency with the standard surgical practice. The information may initiate the treatment guideline for the patient with extracranial carotid artery stenosis in Thailand.*

Keywords: *Carotid endarterectomy, Carotid artery stenosis, Stroke*

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Severe stenosis of extracranial internal carotid artery has been identified in 9.2% of patients with ischemic stroke by duplex ultrasonography in Thailand[1]. Carotid endarterectomy, the most effective treatment of this disease has not been well established countrywide due to the under recognition in general medical practice, the possible serious complication after procedure, and the high expectation for successful outcome of this treatment. The objectives of the present study were to evaluate the safety of carotid endarterectomy at our institute by the outcomes of perioperative mortality rate and major stroke rate, as well as the efficiency of this procedure by the long-term results of mortality rate related to the disease and ipsilateral ischemic stroke rate, and the long-term stroke-free survival rate.

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Material and Method

Study design

The design was an observation study with long-term follow-up in the first 100 consecutive patients that underwent carotid endarterectomies for the symptomatic carotid artery stenoses.

Patient selection for carotid endarterectomy

The patients presenting with the symptoms of ischemic stroke with good recovery underwent the non-invasive tests to identify the stenosis of extracranial internal carotid arteries. Duplex ultrasonography, the initial investigation demonstrated the severely stenotic lesions by the criteria of the peak systolic velocity ratio between the internal carotid artery and the common carotid artery of more than 1.8[2]. Computed tomographic angiography was the final investigation to confirm the more than 70.0% diameter stenosis of the internal carotid artery[3]. Preoperative neurological recovery, cardiovascular status, and general condition were assessed among these patients by neurologists, cardiologists, anesthesiologists, and vascular surgeons. The contraindications of this surgical treatment were disabling stroke, concomitant severe intracranial carotid lesions, inaccessible surgical sites, hostile neck (previous radiation, post radical neck dissection, tracheostomy), and compromised cardiopulmonary status. All symptomatic patients with suitable conditions were scheduled for carotid endarterectomy.

Surgical technique

The surgical treatment was carried out under general anesthesia[4]. Systolic blood pressure was maintained at 120 to 180 mmHg during the procedure. Common carotid artery, external carotid artery, and internal carotid artery were isolated through a longitudinal incision along the medial border of sternocleidomastoid muscle. The gentle dissection of these arteries was essential to avoid the embolization of atherosclerotic plaque. The preservations of internal jugular vein, mandibular marginal branch of facial nerve, hypoglossal nerve, and vagal nerve were required. Systemic heparinization (80 units per kilogram body weight of unfractionated heparin) was routinely administered before the carotid arteries were cross clamped. A long arteriotomy was carried out on the anterior wall of the common carotid artery and the internal carotid artery. An intravascular shunt was routinely inserted into the internal carotid artery at the distal end and into the common carotid artery at the proximal end, Fig. 1A[5]. The endarterectomy was commenced in the common carotid artery in the plane between the tunica media and the tunica adventitia[6]. The proximal end of atherosclerotic plaque was sharply cut and removed from the wall of common carotid artery. The atherosclerotic plaque dissection was continued upwardly toward the internal carotid artery. The distal end of atherosclerotic plaque was usually

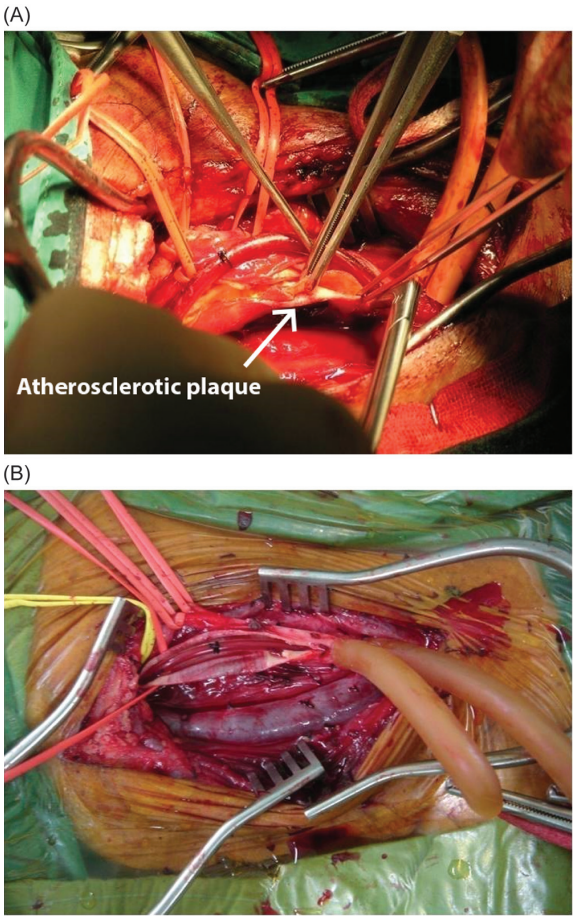


Fig. 1 Carotid endarterectomy with insertion of intravascular shunt into internal carotid artery at the distal end (left side) and into common carotid artery at the proximal end (right side). A) before atherosclerotic plaque removal, B) after atherosclerotic plaque removal.

easily separated from the intimal layer of the internal carotid artery. Whenever this step was difficult, the thin atherosclerotic plaque at the most distal part with firmly adhesive to the endothelium was sharply cut in order to avoid further distal dissection of the intimal layer of internal carotid artery and the subsequent arterial thrombosis after the procedure. Then, the arterial wall at this area was secured by the multiple interrupted suture fixations with 6/0 polypropylene. The atherosclerotic plaque from the external carotid artery was finally removed by the eversion endarterectomy technique. The pieces of arterial wall in the tunica media, containing smooth muscle cells were completely removed. The inner surface of the artery would have shiny appearance when this step was accomplished,

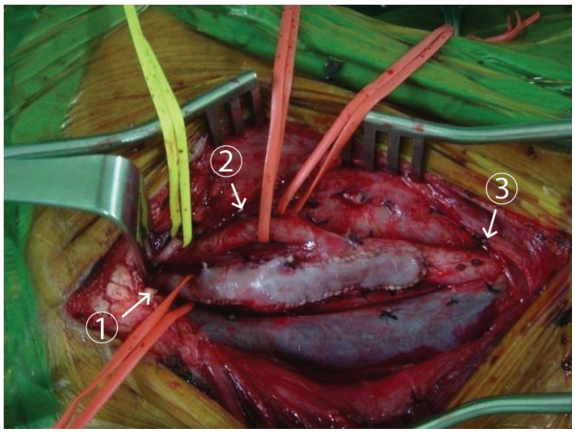


Fig. 2 Arteriotomy closure with long saphenous vein patch. 1) internal carotid artery, 2) external carotid artery, 3) common carotid artery.

Fig. 1B. The long arteriotomy was routinely closed with saphenous vein patch[7], Fig. 2. During the final step, the intravascular shunt was removed and heparinized saline was flushed into the lumen to eliminate air bubbles. After the complete arteriotomy closure, the vascular clamp on the internal carotid artery was temporarily released and reapplied at the most proximal part of this artery. Then, the vascular clamps on the external carotid artery and the common carotid artery were respectively released to allow blood flow passing only into the extracranial circulation. This maneuver could warrant the complete clearance of any residual small particles and air bubbles in the lumen of common carotid artery prior to the release of the internal carotid vascular clamp for cerebral revascularization. Dexamethasone was intravenously administered during the procedure prior to the cerebral reperfusion and the 24-hour postoperative period. All bleeding sites at the surgical area were meticulously secured by electric cauterizations and suture ligations. The surgical wound was finally closed in layer without any tube drain.

Postoperative care and follow-up

Postoperatively, the patients were closely observed in the intensive care unit with the monitoring of vital signs, consciousness, muscle power of the bilateral upper and lower extremities, and urine output. The systolic blood pressure must be maintained between 120 and 180 mmHg. Intravenous fluid was infused to provide urine output at least 1 ml/kg/hr. The patients were kept in the semi-upright position with the head up to 30 degree. Statin was prescribed only in patients with hypercholesterolemia. All activities and oral food intake were allowed at postoperative day 1 when the patients had good consciousness, stable vital signs, no extremity weakness, and adequate urine output. The abnormal neurological signs were closely observed at the perioperative period. Aspirin (81 mg) once daily, continuously administered in the preoperative period was the main postoperative oral medication. The appropriate control of atherosclerotic risk factors such as of diabetes mellitus, hypertension, and hypercholesterolemia were also scheduled during postoperative period[8]. In the long-term follow-up, survival, evidence of cerebral ischemia and quality of life were regularly assessed every three months during the first year after surgery and then every six months. Duplex ultrasonography to visualize bilateral carotid arteries was regularly carried out every six months.

Data collection

The 100 consecutive symptomatic patients who underwent carotid endarterectomy between January 1997 and December 2012 were enrolled in this study. The perioperative information of these patients including demographic data, comorbidities, status of contralateral carotid artery, presenting neurological symptoms, details of surgical procedure, estimated blood loss, length of ICU stay, perioperative mortality and morbidities were identified from the case record forms with the permission from the Ethic Committee and Administrative Committee of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand; Ethics approval No. 100/2554 (EC2). The long-term follow-up information including, mortality, cause of death, evidence of stroke, stroke free survival, and life activity were obtained from the outpatient record forms. The Kaplan-Meier technique was used to generate survival curves for cumulative stroke free survival. All statistical calculations were done using SPSS software (version 11.5, license 30001359390).

Results

The outcomes of the 100 consecutive symptomatic patients with severe stenosis of extracranial internal carotid arteries underwent carotid endarterectomies were analyzed in the present study. Demographic data including gender, age distribution, comorbidities, status of contralateral carotid artery, and neurological presentations were summarized in Table 1. There were 68 male (68.0%) and 32 female (32.0%), the mean age at the time of operation was

69.9±10.2 years (range 51-84). The affected carotid arteries were nearly equal between left side (49%) and right side (51%). The status of the contralateral carotid artery included complete occlusion in 10 patients (10.0%) and severe stenosis in 10 patients (10.0%). Hypertension (87%) was the most common comorbidity in the present series, followed by hypercholesterolemia (69%), diabetes mellitus (41%), and ischemic heart disease (37%). Hemiparesis (64%) was the most common neurological symptom of these patients, followed by facial weakness (26%), loss of consciousness (14%), dysarthria (12%), and monocular visual loss (11%). The mean duration of neurological symptoms prior to surgery in these patients was 2.5±0.8 months with the range between 0.5 and four months.

Table 1. Demographic informations, comorbidities, status of contralateral carotid artery and neurological symptoms of 100 patients undergoing carotid endarterectomy

	Number (%) (n = 100)
Gender	
Male	68 (68.0)
Female	32 (32.0)
Age (years) at the time of operation	
Range	51-84
Mean ± SD	69.9±8.3
Comorbidities	
Hypertension	87 (87.0)
Hypercholesterolemia	69 (69.0)
Diabetes mellitus	41 (41.0)
Ischemic heart disease	37 (37.0)
Smoking	20 (20.0)
Renal failure	7 (7.0)
Pulmonary disease	3 (3.0)
Peripheral artery disease	2 (2.0)
Status of contralateral carotid artery	
Normal	14 (14.0)
Atherosclerotic plaque without severe stenosis	66 (66.0)
Atherosclerotic plaque with severe stenosis	10 (10.0)
Complete occlusion	10 (10.0)
Neurological symptoms prior to surgery	
Hemiparesis	64 (64.0)
Facial weakness	26 (26.0)
Loss of consciousness	14 (14.0)
Dysarthria	12 (12.0)
Uniocular visual loss	11 (11.0)
Aphasia	7 (7.0)
Vertigo	3 (3.0)
Surgical side	
Left carotid artery	49 (49.0)
Right carotid artery	51 (51.0)

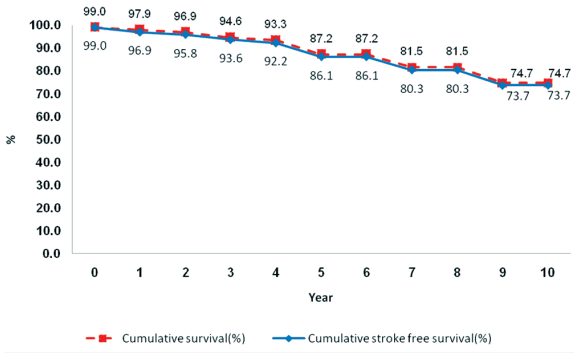
Table 2. Summary of perioperative mortality and morbidities in the consecutive 100 patients

Complications	Number (%) (n = 100)
Mortality	1 (1.0)
Morbidities	
Intracerebral hemorrhage	1 (1.0)
Transient hemiplegia	1 (1.0)
Focal seizure	1 (1.0)
Cranial nerve injuries	6 (6.0)
- Facial palsy (low motor)	3 (3.0)
- Longue deviation	3 (3.0)
Wound hematoma	2 (2.0)

Intraoperatively, the mean duration of the surgical procedures was 210±40 minutes (range 90-270 minutes). The mean duration of total carotid shunting and carotid cross clamp time during shunt removal were 75±21 minutes (range 30-120 minutes) and 4.5±0.6 minutes (range 3.6-6.3 minutes) respectively. Estimated blood loss was 150±20 ml. The mean length of postoperative intensive care was 1.4±0.6 days.

Postoperatively, the 30-day perioperative mortality occurred in one patient (1%), Table 2. The cause of death in this patient was massive intracerebral hemorrhage at postoperative day 7. The morbidities were also summarized in Table 2. One patient (1%) had transient contralateral hemiplegia at postoperative day 17 with three-hour recovery. One patient (1%) had an episode of focal seizure for 30 seconds without neurological localizing sign. Six patients (6%) had transient cranial nerve dysfunctions, three (3%) facial palsy, and three (3%) tongue deviation. Two patients (2%) had surgical wound hematoma, which completely subsided with conservative treatment.

Stroke free survival of the long-term follow-up in the patients undergoing carotid endarterectomy was demonstrated in Fig. 3. The mean follow-up period was 8.9±0.3 years. Cumulative stroke free survival after surgery for five years and 10 years were 86.1% and 73.7% respectively. One of the 10 patients who had severe stenosis of contralateral internal carotid artery underwent carotid endarterectomy due to the contralateral ischemic stroke at 1 year after the initial surgery. This patient had an uneventful recovery with active life since then. Among 12 patients passing away during the follow-up period, there was no mortality related to ischemic stroke and surgical procedure. The causes of death were ischemic heart disease in four patients, chronic obstructive pulmonary disease in two, cancer in two, septicemia in two, trauma in one, and renal failure in one. By duplex ultrasound examination twice a year, there were no recurrent stenoses on the surgical sites among all survivals after surgery.



Years	0	1	2	3	4	5	6	7	8	9	10
Stroke free (n)	99	97	96	94	93	89	89	87	87	86	86
Follow-up (n)	99	98	97	95	94	90	90	88	88	87	87

Fig. 3 Cumulative stroke free survival during 10 years follow-up.

Discussion

Carotid endarterectomy is the most effective treatment in patients with the symptoms of cerebral ischemia caused by severe stenosis of internal carotid arteries with the significant reduction in the absolute risk of ipsilateral stroke by 17% (±3.5%, $p<0.001$) and major or fatal ipsilateral stroke by 10.6% (±2.6%, $p<0.001$) compared with medical treatment alone at two years. The beneficial outcomes could be obtained when the perioperative mortality rate and major stroke rate of carotid endarterectomy were not exceeded 3% and 5% respectively[9-11].

When the significant stenosis of extracranial carotid artery had been identified in 9.2% of patients with ischemic stroke in Thailand[1], the national program of carotid endarterectomy has to be established for improving the standard health care in the country. The first 100 consecutive case series of carotid endarterectomy with 1% perioperative mortality rate and 1% perioperative major stroke rate should warrant the comparable safety of this procedure in our institute. During ten year follow-up, the fact that there were no death related neurovascular events and no recurrent ipsilateral stroke together with the cumulative five and 10 year stroke-free survival of 86.1% and 73.7% respectively, these showed the long-term efficiency of this treatment. Furthermore, there was no recurrent stenosis of affected carotid artery routinely examined by duplex ultrasonography every six months among the survivals. This encouraging information should be able to initiate the treatment protocol of this disease for other medical institutes where the demand of this surgical treatment is required. Subsequently, the successful carotid endarterectomy in many medical institutes could establish the national treatment guideline for this major vascular problem.

The collaboration among neurologists, cardiologists, anesthesiologists, and vascular surgeons should provide the effective patient selection for carotid endarterectomy with safety outcome. To achieve the stroke reduction risk compared with medical treatment, the suitable time of carotid endarterectomy should be within 12 weeks after the last cerebral ischemic symptoms and within two weeks for the greatest benefit[12]. However, the timing of surgery in some patients of the present study was slightly longer than the ideal situation due to the delayed referral of these patients from general practitioners. Early detection of carotid artery stenosis in stroke patients by duplex ultrasound should be encouraged among general medical practice in the country.

In the current situation, there are several controversies in the surgical procedure such as appropriate anesthesia during operation, the necessity of intravascular shunting during carotid cross clamp, and the benefit of vein patch for arteriotomy closure. There are no conclusions among these issues. The surgical procedure of carotid endarterectomy was consistent in our institute representing one-sided preference of those controversies with the satisfactory outcomes. The operations in the present series were totally carried out under general anesthesia for the effective control of patients' compliances. The major disadvantage of general anesthesia is the inability to evaluate the patient's consciousness during the procedure. Close observation of consciousness, the important clinical monitoring to warrant the adequacy of cerebral circulation during the cross clamp of carotid artery is possible when the procedure is carried out under local[13,14] or regional anesthesia[15]. Selective intravascular shunting would be limited to the patients with alteration of consciousness during carotid cross clamp due to inadequate cerebral perfusion. However, the patient's tolerance is not promising when the procedure is carried out under these types of anesthesia. Regarding the reassurance of adequate cerebral perfusion with the procedure carried out under general anesthesia, we routinely inserted intravascular shunts into the carotid artery systems during atherosclerotic plaque removals[16,17]. In order to avoid the embolization of atherosclerotic plaque during the shunting procedure, a long arteriotomy was carried out toward the normal areas of the internal carotid artery and the common carotid artery. Then, the intravascular shunt was

inserted through these arterial sites. We considered that intravascular shunting during carotid endarterectomy was simple and safe without the requirement of intraoperative complex monitoring system of cerebral perfusion[18,19]. There was no major ischemic stroke in the perioperative period of the present series. All patients woke up immediately during the recovery period from general anesthesia. The outcome of this surgical technique was promisingly safe compared with the surgery carried out under local or regional anesthesia. In addition, this technique allowed surgeons to perform the procedures meticulously without mental stress in the highly expected treatment.

Regarding the surgical technique of atherosclerotic plaque removal, the dissection at carotid arterial wall was performed deeply toward the external elastic lamina in order to adequately remove the residual smooth muscle cells in the tunica media, which were responsible for the recurrent carotid stenosis due to myointimal hyperplasia[20]. This time-consuming maneuver provided no evidence of the recurrent carotid artery stenosis in the long-term follow-up examined by duplex ultrasonography. With the enlarged intraluminal diameter of affected carotid artery, it was reasonable to perform patch arterioplasty for arteriotomy closure to reduce the risk of perioperative carotid artery occlusion[21,22], the most serious complication with major neurovascular events. There was no aneurysmal change at the site of saphenous vein patch confirmed by duplex ultrasonography. Performing these meticulous techniques in all patients could explain the mean operative time in the present series was relatively long compared with the procedures without these maneuvers. The complete hemostasis was the last essential step of procedure to avoid postoperative hematoma at surgical area. Infective complication following surgical wound hematoma, the possible fatal event must be completely prevented.

The appropriate control of blood pressure was the most important measure to reduce perioperative complication[23]. In our protocol, systolic blood pressure had to be maintained above 120 mmHg to avoid watershed cerebral infarction[24], and below 180 mmHg to prevent cerebral hyperperfusion and intracranial hemorrhage during perioperative period[25]. At the early stage of carotid endarterectomy program of our institute, we lost one patient who had an uneventful recovery seven days after the surgery but received the inappropriate control of high blood pressure. He suddenly lost consciousness while taking a shower and developed a rapid episode of cardiopulmonary arrest and passed away one hour later. The autopsy findings were a large intra-cerebral hematoma and brain herniation as the causes of death. These findings should be related to hyperperfusion syndrome after carotid endarterectomy[26,27]. There was no organized thrombus in the lumen of carotid artery and no hematoma at surgical area. Retrospectively, he had high blood pressure for four days before the fatal event. Furthermore, he had a complete occlusion on the contralateral internal carotid artery. This problem might precipitate the intra-cerebral hemorrhage due to the abnormal integrity of intracranial arterial wall[28]. After this event, our perioperative treatment had an intensive protocol of blood pressure control. Since then, this major complication was not found again despite carotid endarterectomies in the nine patients with complete occlusion of contralateral carotid arteries. During the long-term follow-up, all survivors had good quality of life without any of the clinical evidence of subsequent ipsilateral cerebral ischemia. This information could confirm the long-term efficiency of carotid endarterectomy in the present series.

In conclusion, carotid endarterectomy of the present series with the consistent surgical technique by routine use of general anesthesia during the procedure, intravascular shunting during carotid cross clamp, and vein patch for arteriotomy closure provided the comparable perioperative and long-term outcomes in the standard requirement. The appropriate patient selection, the meticulous surgical technique, the intensive perioperative medical management, the appropriate control of atherosclerotic risk factors, and the collaboration among the physicians in taking care of these patients were the key points to achieve the highly expected treatment program. The information of the present series may be useful for any medical institute where carotid endarterectomy program is planned to establish for the improvement of treatment outcome in stroke patients.

What is already known on this topic?

Extracranial internal carotid artery stenosis is one of the major causes of ischemic stroke. This clinical problem was recognized in 9.2% of Thai patients. Carotid endarterectomy is the most effective treatment in patients with symptomatic severe stenosis of internal carotid arteries. The absolute reduction risk of ipsilateral ischemic stroke compared with medical treatment was 17% (±3.5%, $p<0.001$). The beneficial outcome could be obtained when the perioperative

mortality rate and major stroke rate of carotid endarterectomy were not exceeded 3% and 5% respectively.

What this study adds?

The long-term outcome of carotid endarterectomy with the consistent surgical technique for the symptomatic carotid artery stenosis in Thai patients was firstly available in this study. The result of carotid endarterectomy in this series, comparable with the international standard quality, should encourage the recognition of this disease entity in Thai patients with stroke and provide the information to set up the protocol of this treatment in Thailand.

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Potential conflicts of interest

None.

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การผ่าตัดลอกแผ่นไขมันภายในหลอดเลือดแดงบริเวณคอในผู้ป่วยที่มีอาการทางสมองขาดเลือด: ประสบการณ์ในผู้ป่วย 100 ราย

ประมุข มุทิรางกูร, เฉนียน เรืองเศรษฐกิจ, ชุมพล ว่องวานิช, ณัฐวุฒิ เสริมสาธนสวัสดิ์, คามิน ชินศักดิ์ชัย, สุธีคณิต หัถพรสวรรค์, เกียรติศักดิ์ หงส์คู, ณัฐวุฒ พ่วงพันธุ์งาม

ภูมิหลัง: *การศึกษาผู้ป่วยอัมพาตจากสมองขาดเลือดโดยการตรวจสภาพหลอดเลือดแดงบริเวณคอที่นำเลือดไปเลี้ยงสมองด้วยเครื่องอัลตราซาวด์ พบว่ามีการตีบแคบขั้นรุนแรงของหลอดเลือดบริเวณนี้สูงถึงร้อยละ 9.2 การผ่าตัดลอกแผ่นไขมันภายในหลอดเลือดแดงบริเวณคอเป็นการรักษาที่ดีที่สุดสำหรับผู้ป่วยที่มีโรคนี้ แต่การผ่าตัดดังกล่าวยังไม่เป็นที่นิยมในประเทศไทยเนื่องจากเป็นการรักษาที่มีความคาดหวังจากผู้ป่วยสูง แต่มีโอกาสเกิดภาวะแทรกซ้อนที่รุนแรงได้หากการรักษาไม่มีการวางแผนเตรียมพร้อมที่ดีพอ*

วัตถุประสงค์: *เพื่อศึกษาด้านความปลอดภัยและด้านประสิทธิผลของการผ่าตัดลอกแผ่นไขมันภายในหลอดเลือดแดงบริเวณคอในผู้ป่วย 100 ราย ที่มีอาการทางสมองขาดเลือด*

วัสดุและวิธีการ: *การศึกษาติดตามผลการรักษาโดยรวบรวมข้อมูลของผู้ป่วย 100 ราย ที่มีอาการทางสมองขาดเลือดจากหลอดเลือดแดงบริเวณคอตีบแคบอย่างรุนแรง (มากกว่าร้อยละ 70 ของเส้นผ่าศูนย์กลาง) และได้รับการผ่าตัดลอกแผ่นไขมันภายในหลอดเลือดแดงบริเวณนี้ การผ่าตัดดังกล่าวในผู้ป่วยทุกรายกระทำโดยการดมยาสลบ สอดใส่สายสวนภายในหลอดเลือดแดงบริเวณคอเพื่อเป็นทางนำเลือดไปเลี้ยงสมองตลอดเวลาและใช้ผนังของหลอดเลือดดำชั้นตื้นของขาร่วมในการเย็บซ่อมแซมปิดผนังหลอดเลือดแดง การศึกษาด้านความปลอดภัยของการผ่าตัดวัดจากอัตราการเสียชีวิตและอัตราการเกิดอัมพาตอย่างรุนแรงภายหลังการผ่าตัด 30 วัน การศึกษาด้านประสิทธิผลของการผ่าตัดวัดได้จากอัตราการอยู่รอดโดยไม่มีภาวะอัมพาตจากสมองขาดเลือดในระยะเวลา 10 ปี*

ผลการศึกษา: *ผู้ป่วย 100 ราย เป็นชายร้อยละ 68 และหญิงร้อยละ 32 โดยมีอายุเฉลี่ย 69.9 ปี อัมพาตครึ่งซีกของร่างกายเป็นอาการที่พบบ่อยมากที่สุดคิดเป็นร้อยละ 64 ที่ทำให้ผู้ป่วยต้องรับการผ่าตัด ระยะเวลาโดยเฉลี่ยระหว่างการเกิดอาการทางสมองขาดเลือดถึงการผ่าตัดนาน 2.5 เดือน ความดันโลหิตสูงเป็นโรคร่วมที่พบมากที่สุดในผู้ป่วยกลุ่มนี้คิดเป็นร้อยละ 87 ระยะเวลาที่ใช้ในการผ่าตัดโดยเฉลี่ยนาน 210 นาที ระยะเวลาที่ผู้ป่วยต้องพักฟื้นในห้องอภิบาลโดยเฉลี่ยนาน 1.4 วัน อัตราการเสียชีวิตภายหลังการผ่าตัดร้อยละ 1 อัตราการเกิดอัมพาตขั้นรุนแรงร้อยละ 1 ในช่วงเวลาติดตามผลการรักษาในระยะยาว พบว่าไม่มีผู้ป่วยรายใดเสียชีวิตจากภาวะสมองขาดเลือด และผู้ป่วยที่รอดชีวิตไม่มีภาวะอัมพาตเกิดขึ้นซ้ำใหม่ อัตราผู้ป่วยที่รอดชีวิตโดยไม่มีภาวะอัมพาตในช่วงระยะเวลา 5 ปี และ 10 ปี คิดเป็นร้อยละ 86.1 และ 73.7 ตามลำดับ*

สรุป: *การผ่าตัดลอกแผ่นไขมันภายในหลอดเลือดแดงบริเวณคอมีความปลอดภัยและมีประสิทธิผลในผู้ป่วยที่มีภาวะสมองขาดเลือดจากการตีบแคบขั้นรุนแรงของหลอดเลือดแดงบริเวณคอที่ไปเลี้ยงสมอง ขั้นตอนและผลการผ่าตัดวิธีนี้อาจนำมาใช้เป็นแนวทางการรักษาผู้ป่วยโรคนี้ในประเทศไทย*