Percutaneous transluminal angioplasty (PTA) is being extensively applied to treat arteriosclerotic lesions. However, this application has not been widely accepted for the treatment of carotid artery stenosis. Successful attempts to relieve cerebral ischemia from extracranial carotid arterial stenosis by PTA are reported. Twenty-seven patients with arteriosclerotic stenosis, fibromuscular disease, and Takayasu carotid arterial stenosis were treated by PTA. All anatomic carotid stenotic lesions were corrected without any neurologic complication. Follow-ups ranged from 3 months to 4 years without recurrent symptoms in any patient. These results may suggest that some patients with cerebral ischemia secondary to extracranial carotid artery stenosis may be treated safely and effectively by PTA.

Percutaneous transluminal angioplasty (PTA), an angiographic but nonsurgical treatment for vascular occlusive disease, was first described by Dotter and Judkins [1] in 1964. It has become popular in the recent years after the introduction of the Gruntzig and Hopff [2] balloon dilatation catheter. Angioplastic dilatations have been reported in coronary, renal, mesenteric, celiac, aortoiliac, femoral, and more peripheral arteries. Recently, angioplasty has been applied to brachiocephalic arteries, but primarily to the subclavian, innominate, vertebral, or external carotid artery [3-7]. Transluminal dilatation of the carotid artery has been performed rarely because of the fear of cerebral emboli from ulcerative plaque. There have been only few scattered cases reported in the past years [3-12]. We report our successful experience with PTA at different levels of the carotid artery in 27 patients.

Subjects and Methods

Thirty-four patients were referred for carotid angioplasty. Twenty-seven patients undergoing 29 procedures are included in this report. Twenty-one patients had arteriosclerotic stenosis, five had fibromuscular dysplasia, and one had Takayasu arteritis. Among the 27 patients, 12 were male and 15 were female. They were 34–84 years old (average age, 72). (Males were younger than females by about 12–15 years.) The fibromuscular dysplasia and Takayasu patients tended to be younger than those having atherosclerosis (the youngest was 34 years old with Takayasu and 40 years old with fibromuscular dysplasia). Seven patients had proximal common carotid artery stenosis, three had distal common carotid artery stenosis, four had stenosis at the carotid bifurcation, six had internal carotid artery stenosis, two had external carotid artery stenosis, five had fibromuscular disease of the internal carotid artery, and two had bilateral carotid artery disease.

All patients were monitored, with electroencephalography (EEG) during the procedure, except those undergoing external carotid artery PTA. The patients were medicated with intravenous Valium 5–10 mg and Decadron 10 mg. Heparin 5000 units was given right after the PTA catheter was introduced into the carotid artery. Injection of heparinized arterial blood into the carotid artery through a balloon catheter without the placement of a guide wire was performed during inflation of the balloon. Persantine 50 mg was administered orally three times a day for about 3 months after dilatation. Prednisone was also given to patients (the
Fig. 1.—Case 1. Proximal common carotid artery angioplasty. DSA of aortic arch (A) and selective left common carotid angiogram (B) show severe stenosis of left proximal common carotid artery (arrow). C, Inflated balloon in proximal left common carotid artery. D, Left carotid angiogram after PTA clearly shows full dilatation of proximal left common carotid artery.

Fig. 2.—Case 2. Proximal common carotid artery angioplasty. A, Arch angiogram with left axillary catheter. High-degree stenosis in left subclavian artery (large arrow) and severe stenosis at origin of left common carotid artery (small arrows). Left vertebral artery was occluded. B, Postangioplasty angiogram. Full dilatation of origin of left common carotid artery. C, Repeat arch angiogram. Full dilatation of left subclavian and left common carotid arteries.

last 19 patients) for 1 week (tapering from 30 mg to 5 mg over a 6 day period). The balloon catheter was made by Medi-Tech; it was ordered specially with a 5 mm short tip. The size of the balloon was tailored to the length of stenosis and caliber of the carotid artery (balloon diameter ranged from 4 to 10 mm).

Results

In seven of the 34 patients referred for PTA, it could not be performed: Two of the seven were terminated because loose plaque and ulcerative plaque were demonstrated by conven-
tional angiography (not seen on digital subtraction angiography [DSA]); two patients had a very tortuous proximal internal carotid artery (one with fibromuscular dysplasia and one with stenosis); and in three patients the procedure was discontinued because of EEG changes with spiking and slow waves occurring while passing a balloon catheter through the stenotic segment. We did not have any complications during or after the angioplasty procedure except for a large groin hematoma. All 27 patients have been well during follow-up periods of 3 months to 4 years.

Representative Case Reports

Case 1 (fig. 1)

A 72-year-old woman was admitted for evaluation of intermittent right and left hemiparesis, slurred speech, and blurred vision of the left eye. DSA disclosed stenosis of the right common carotid bifurcation and severe stenosis of the left proximal common carotid artery. Conventional carotid angiography confirmed the DSA findings and a smooth luminal stenosis of left proximal common carotid measuring about 2.5 mm. PTA was performed with a 10 mm by 4 cm balloon catheter. The caliber was dilated up to 10 mm, and after angioplasty, she was able to speak better and had no blurring of vision. She then had a right carotid endarterectomy. Since then, she was well after more than 18 months later.

Case 2 (fig. 2)

A 57-year-old man presented with increasing difficulty in speech, right-sided weakness for several weeks, and left arm pain. Angiography demonstrated severe stenosis of the proximal left common carotid artery and total occlusion of the left vertebral artery with moderate stenosis of the left subclavian artery distal to it. PTA of the left subclavian artery was performed through the left transaxillary approach and the left proximal common carotid artery was dilated from 2 mm to 8 mm with a 8 mm x 3 cm balloon catheter via the femoral route. He was still symptom-free 25 months later.

Case 3 (fig. 3)

A 34-year-old woman with previous diagnoses of Takayasu disease was transferred to our hospital after a few months of increasingly blurred vision in the left eye, slurred speech, and difficulty in finding words. She also had right arm pain with very faint brachial and radial pulses, a palpable right axillary pulse, and pain in her left arm after exercise. DSA showed a total occlusion of right subclavian artery and a long-segment stenosis of the left proximal common carotid artery. Conventional angiography demonstrated the same findings, yet no definite abnormality was found in the left subclavian artery. The stenotic segment measured about 6 cm in length, tapering from 3.5 mm to 0.5 mm from its proximal origin. PTA was performed with an 8 mm x 4 cm balloon catheter from the distal to the proximal portion of the segment. She was still free of visual complaints and had no speaking problems 5 months later.

Case 4 (fig. 4)

A 66-year-old woman presented with staggering gait and increasing dysarthria, dysphasia, and a right hemiparesis over 2 days. Her left arm blood pressure measured about 65 mm Hg less than her right arm. Diffuse posterior fossa atrophy as well as left frontal lobe and basal ganglia infarcts were noted on CT. Angiography disclosed nonfilling of both vertebral arteries and severe stenosis of the left subclavian artery. The left internal carotid artery was totally occluded and there was moderate stenosis of the distal common carotid artery. PTA of the left subclavian artery was performed with an 8 mm by 3
Fig. 4.—Case 4. Subclavian and distal common carotid artery angioplasty. 


Fig. 5.—Case 5. Weblike stenosis of common carotid bifurcation. Frontal (A) and lateral (B) views of right common carotid arteriogram. Partial weblike stenosis at right common carotid bifurcation. C, Web stenosis was dilated by angioplasty.

cm balloon catheter. Despite significant improvement in her gait, she was readmitted 5 months later with a dense hemiparesis and aphasia. Repeat angiography showed no evidence of restenosis of the previously dilated left subclavian artery. A small left vertebral artery was demonstrated; it had not opacified before angioplasty. The left distal common carotid artery was dilated with an 8 mm \( \times \) 3 cm balloon catheter in an effort to improve collateral supply via the external carotid artery. Better opacification of the basilar and internal carotid...
Fig. 6.—Case 6. Carotid bifurcation and proximal internal carotid artery stenosis. A, Severe stenosis was seen at both proximal internal carotid arteries. Ulcerative plaque at left carotid bifurcation. Right internal carotid artery is much narrower than left. B, Immediate postangioplasty arteriogram shows wider caliber of right internal carotid artery; intimal split (arrow). C, Arteriogram 6 months later. Healing of right internal carotid artery. No intimal split (arrow).

arteries through the occipital and internal maxillary arteries was obtained. Six months after the second angioplasty, she was found to have no significant ataxia and better strength in the right leg. She still had a marked dysphasia but was able to speak a few words. Her right arm weakness was unchanged.

Case 5 (fig. 5)

A 64-year-old man was admitted because of a syncopal episode and transient loss of consciousness. He also had slight weakness in his left extremities. He has been treated for hypertension over the previous 4 years. A loud bruit was heard in the right side of his neck. Angiography disclosed a weblike stenosis at the right common carotid bifurcation. The vertebral arteries were normal. Angioplasty of the distal common carotid artery was performed with a 10-mm-diameter and 2-cm-long balloon catheter. The patient had been followed for over 17 months without recurrent symptoms.

Case 6 (fig. 6)

A 54-year-old man was admitted for evaluation of increased drowsiness and weakness in both extremities. Occasionally he felt numbness in his left arm. He has been a heavy smoker and alcoholic for more than 30 years. He also had transient slurred speech. Angiography demonstrated a high-degree stenosis of both carotid bifurcations, stenosis of the left subclavian artery, and narrowing at the origin of both vertebral arteries. Ulcerative plaques were seen at the left carotid bifurcation. He had right internal carotid artery angioplasty before left carotid endarterectomy. The stenotic segment of the right internal carotid artery was only 1.5 mm, just enough to pass the 5-mm-diameter balloon catheter. Subsequently, he had several episodes of right hemiparesis and a speech problem after left carotid endarterectomy, but he recovered with mild weakness. At 1 and 6 months after surgery, follow-up angiography showed total occlusion of left carotid artery. The right internal carotid artery had further healing of the intimal split, and the lumen appeared smoother and remained open. After surgery, he also had left proximal subclavian artery angioplasty with a 10-mm-diameter and 3-cm-long balloon to improve his left arm ischemia and gait problem. After that, he was well after more than 18 months later.

Case 7 (fig. 7)

A 67-year-old woman was admitted for evaluation of left-sided weakness and increasing confusion for several weeks. She also complained of pain and tingling in her left arm. Before admission, she was found on the floor at home with an injury to her left hip and leg. Multiple small lacunar infarcts were seen on CT. Angiography disclosed a long, 3.0 cm segment of severe stenosis in the proximal right internal carotid artery. Angioplasty of the right internal carotid artery was performed with a 6 mm x 5 cm balloon catheter before her pelvic surgery. She was well with very mild residual hemiparesis after more than 11 months later.

Case 8 (fig. 8)

A 63-year-old man presented with recent myocardial infarct with multiple coronary arterial stenoses. He also had intermittent left-sided weakness and a right carotid bruit. A high-degree stenosis of the right proximal internal carotid artery was disclosed by angiography. Anticoagulant with heparin, Persantine, and aspirin were initiated after angiography. Dilatation of the right internal carotid artery was recommended before cardiac bypass surgery. Angioplasty was performed with a 6 mm x 3 cm catheter, but the lumen was dilated to 5 mm only. Despite that, the intermittent right-sided weakness resolved. He then underwent cardiac triple bypass surgery. He was still well after about 4 months later.
A 73-year-old woman began to have left ophthalmoplegia with decreasing visual acuity of the left eye after having several left frontal headaches. She also had diplopia and dropping of the left eyelid. Angiography demonstrated a 2-cm-long stenotic segment of the left internal carotid artery just distal to the petrous and proximal to the cavernous segment. In addition, a large aneurysm was seen in the cavernous internal carotid artery. Angioplasty dilatation of the distal internal carotid artery was performed at the time of balloon embolization. The aneurysm was then embolized with a detachable balloon. About 2 months later, repeat angiography showed the dilated segment still patent.

A 60-year-old woman was admitted to evaluate the cause of intermittent attacks of aphasia and mild weakness in both sides. She had had a right cerebral stroke 1 year before with mild residual left-sided weakness. Angiography disclosed a total occlusion of the right internal carotid artery and about a 40% stenosis of the left proximal internal carotid artery. DSA, however, showed a very small, slitlike residual lumen and stopped at about 3 cm above the origin of the right internal carotid artery. The origin of the right external carotid artery was also slightly narrowed. PTA of the right external carotid artery and possibly the internal carotid artery was recommended before external–internal carotid bypass and left carotid artery endar-
Case 9 (fig. 9)

A 56-year-old woman was admitted for evaluation of increasing left-sided weakness over a period of 2 months before admission. She also had pain and tingling in her face. She had had a left cerebral stroke 4 years before. Angiography demonstrated fibromuscular dysplasia in both internal carotid arteries. Balloon angioplasty dilatations were performed to treat the bilateral internal carotid artery stenosis caused by fibromuscular dysplasia. She was still symptom-free after more than 16 months later.

Case 11 (fig. 11)

A 56-year-old woman was admitted for evaluation of increasing left-sided weakness over a period of 2 months before admission. She also had pain and tingling in her face. She had had a left cerebral stroke 4 years before. Angiography demonstrated fibromuscular dysplasia in both internal carotid arteries. Balloon angioplasty dilatations were performed to treat the bilateral internal carotid artery stenosis caused by fibromuscular dysplasia. She was still symptom-free after more than 16 months later.

Case 12 (fig. 12)

An 84-year-old man had sudden onset of left-sided weakness 4 days before admission. He also had severe right-sided headaches and vertigo with dizziness and mild ataxia. He had a suprapubic catheter because of a chronic urethral stricture. A huge vesical stone was found. Angiography disclosed a total occlusion of the right internal carotid artery with severe stenosis of the proximal right
PTA of the right external carotid artery was performed to improve the cerebral circulation before cystoscopy with cystourethrotomy. The right external carotid artery was dilated from 2.5 mm to 6 mm by a 6 mm × 3 cm balloon catheter.

**Discussion**

PTA of the brachiocephalic arteries has been performed more frequently in the last 5 years. However, it has been limited to the subclavian, innominate, vertebral, and external carotid arteries [3–9, 13–16]. Balloon angioplasty of the carotid artery was first reported in 1980 by Kerber et al. [7], who dilated the proximal common carotid artery during distal carotid endarterectomy. After that, a few isolated cases having retrograde intraoperative balloon angioplasty of the common carotid artery through an arteriotomy were reported [10, 11]. In 1983, Wiggli and Gratzi [12] described successful dilatation in a case with stenosis of the distal common carotid artery. Tievsky et al. [17] described PTA of postsurgical stenosis in the distal common carotid artery in one case.

Surgical endarterectomy of the proximal common carotid artery carries a high risk and is a rather difficult procedure. Cervical carotid artery bypass is preferred to endarterectomy. Surgical complications may be as high as 23% and include chylothorax, lymph fistula, wound infection, as well as phrenic nerve palsy from extrathoracic surgery [18, 19]. Common carotid artery stenosis is quite different from that of the carotid bifurcation but similar to that at the origin of the brachioce-
Carotid artery. It is usually a smooth luminal stenosis without ulceration [20, 21]. PTA may be performed to correct common carotid stenosis in a similar manner to those cases with stenosis at the origin of the branchiocephalic arteries (figs. 1–4). Surgical treatment of Takayasu arteritis has limited success because of the nature of the disease and the high incidence of graft occlusion [12]. PTA may be a better alternative, as was seen in case 3. In case 4, since the internal carotid artery was totally occluded, angioplasty of the common carotid artery improved collaterals to the internal carotid and basilar arteries and carried the same risk as angioplasty of the external carotid artery.

Arteriosclerotic stenosis at the carotid bifurcation is treated by endarterectomy with excellent results. The operative risk has been reported as 1%-8% mortality and 1%-4% morbidity in the hands of an experienced surgeon [20–36]. PTA of the carotid bifurcation for atherosclerosis may be somewhat controversial at the present time because of the fear of dislodging an ulcerative plaque. It should be restricted to high-surgical-risk patients or those patients with nonatherosclerotic stenosis such as a web or arteritis, as was seen in case 5.

PTA of the internal carotid artery was first reported in 1980 by Mullan et al. [30] in a case of weblike stenosis. Surgical correction of weblike stenosis was considered dangerous because of the distinct possibility of total occlusion of the carotid artery.

Carotid artery stenosis may coexist with coronary artery disease. Mortality in patients with symptomatic coronary artery disease undergoing carotid endarterectomy can be as high as 14%, and cerebral injury may occur during cardiac surgery in patients with carotid artery disease. The incidence of stroke may be as high as 17%. Simultaneous carotid endarterectomy and cardiac surgery has been recommended to reduce complications [22, 23, 26, 29]. From our experience and review of the literature, PTA of a smooth stenotic internal carotid artery may be performed with reasonable safety before cardiac bypass operations or other surgical interventions, as was seen in cases 7 and 8 [31]. In case 6, PTA of the right internal carotid artery preserved the cerebral circulation despite occlusion of the left carotid artery after endarterectomy.

Medial fibroplasia or fibromuscular dysplasia usually occurs in the upper cervical artery and is often not amenable to endarterectomy. In 1981, Hasso et al. [4] first reported the successful dilatation of fibromuscular dysplasia of the internal carotid artery. Since that time, several reports have confirmed the success of PTA in this disease involving the internal carotid artery [20, 21, 30–33]. The "string of beads" appearance of fibromuscular dysplasia may generate turbulence, and mural thrombus may form between the stenotic rings. We recommend treatment with anticoagulant for a period of time before PTA if there are symptoms of transient ischemic attacks to avoid the possibility of dislodging loose thrombus. PTA should not be performed in a very tortuous dysplastic artery because of the difficulty in passing the guide wire and the risk of arterial dissection [32–34].

PTA of the internal carotid artery may also be performed to aid operation in cases where the stenosis is too high and difficult to reach. In case 9, the vertical part of the internal carotid just proximal to the cavernous part was narrowed. It was difficult to pass a detachable balloon through the stenotic segment to occlude the large cavernous aneurysm of the internal carotid artery. PTA allowed us to pass the balloon and successfully occlude the aneurysm.

Surgical intervention has been the traditional method for treating the totally occluded artery. Angioplasty treatment to reopen the total occluded carotid artery has not been reported before. In case 10, the right internal carotid artery was reopened after successful dilatation of the proximal external carotid artery. PTA of totally occluded carotid artery must be reserved for a straight segment, and extreme caution must be used to avoid perforation of the artery. Reverse blood flow may steal carotid circulation from intracranial branches, yet it plays a good protective role to prevent antegrade dislodging emboli.

Cerebrovascular occlusive symptoms often result from stenosis or occlusion of the internal carotid artery, but the external carotid artery may play an extremely important role in providing collaterals to the internal carotid or vertebrobasilar circulation [6, 26, 27]. External carotid arterial stenosis may aggravate the ischemic symptoms in those patients with occlusion of the internal carotid or vertebral arteries. In case 4, PTA of the distal common carotid artery improved the collaterals of the external carotid artery circulation to the internal carotid and basilar arteries. Stenosis of the external carotid artery had increased the ischemic symptoms because of decreasing collaterals. PTA of the external carotid artery improves blood flow through collaterals to the internal carotid artery circulation, as was seen in case 11.

Although short-segment stenosis is the ideal situation for PTA (cases 1 and 2), we have not found any significant difference or difficulty in dilating a longer segment as in cases 3 and 7. Long-segment stenosis may be dilated with a longer balloon or in two stages with shorter balloons. The external carotid artery or the upper internal carotid artery has a greater tendency to develop spasm because of the nature of these arteries. Caution must be taken to avoid spasm during PTA. Spasm distal to the dilated area may be caused by damage to the wall of the artery with the long, stiff tip of the balloon catheter in a tortuous carotid artery. We believe that short-tip balloon catheters may avoid this complication. It is also recommended to avoid overdilatation of the artery. Vasodilators may be given by arterial injection to relieve spasm, but anticoagulant or streptokinase infusion is needed as well to prevent thrombus formation. Vasodilators may be ineffective. We had a patient who developed severe spasm of the iliac artery after angioplasty. The spasm was not relieved despite the use of several vasodilators. General anesthesia eventually relieved the spasm. We believe that general anesthesia may help as a last resort.

Although PTA has not been considered a definitive procedure, we have followed eight patients with DSA. None had evidence of restenosis from 4 months to almost 4 years after PTA. All patients were followed with clinical examinations and were well for 3 months to 4 years. This may be attributed, in part, to the effect of glucosteroids, which are given to all patients.

PTA of the carotid artery may be a somewhat controversial procedure without experience of a larger series and longer
follow-up to compare with surgical results. However, we have
been asked to perform angioplasty in patients who may face
higher risks with surgical endarterectomy, particularly those
with multiple areas of occlusion and cardiac or pulmonary
problems (cases 7 and 8). Until now, no patient has suffered
neurologic complications.

We believe that PTA may be considered an alternative
procedure for improving carotid artery blood flow indepen-
dently or as an adjunct to surgical management. Transluminal
angioplasty may be performed in arteriosclerotic stenosis,
fibromuscular dysplasia, and Takayasu arteritis at different
levels of the carotid artery. It is essential to work closely
with neurologists, neurosurgeons, and vascular surgeons to select
the appropriate cases to avoid complications. Injections of
heparinized arterial blood during dilatation is believed to re-
duce the risk of cerebral ischemia. EEG monitoring is critical
in performing angioplastic dilatation of the carotid artery. We
abandoned the procedure in three potentially high-risk pa-
thents because of EEG changes while we passed the balloon
catheter through the stenotic segment.

Although we need further experience to evaluate the safety
of carotid artery angioplasty, we believe it may be applied
with reasonable safety in carefully selected cases. Shorter-tip
balloon catheters must be used to avoid injury to the lumen
of the carotid artery.

REFERENCES

1. Dotter CT, Judkins MP. Transluminal treatment of arteriosclerotic
stenosis: description of a new technique and preliminary
2. Gruntzig A, Hopf H. Perkutane rekanalisation chronischer arterieller
verschlüsse mit rinem neuren dilatationen-catheter. Dtsch Med
Wochenschr 1974;99:2502–2505
angioplasty of the vertebral arteries. Radiology 1981;139:715–
717
dysplasia of the internal carotid artery. Percutaneous translu-
ninal angioplasty. AJNR 1981;2:175–180
5. Mortarjeme A, Keifer JW, Zuska AJ. Percutaneous transluminal
angioplasty of the brachiocephalic arteries. AJNR 1982;3:169–
174
6. Vitek JJ. Percutaneous transluminal angioplasty of the external
carotid artery. AJNR 1983;4:796–799
7. Kerber CS, Cromwell LD, Lehden OL. Cather dilatation of proximal
carotid stenosis during distal birculation endarterectomy.
AJNR 1980;1:348–349
8. Fogarty TJ, Kinney TB. A new approach to transluminal angi-
fibrous renal artery stenosis dilated by balloon catheter. Acta
10. Pritz MB, Smlon MF. Treatment of tandem lesions of the extra-
11. Hodgins GW, Dutton JW. Subclavian and carotid angioplasties
12. Wiggli U, Gratzi O. Transluminal angioplasty of stenotic carotid
571
14. Block PC, Myler RK, Stertzler S, Falloon JT. Morphology after
1981;305:382–385
15. Clouse ME, Tomashewski JF Jr, Reinhold RE, Costello P. Me-
echanical effect of balloon angioplasty: case report with history.
AJR 1981;137:669–871
17. Tievskey AL, Dray EM, Mardiat JG. Transluminal angioplasty in
postoperative stenosis of the extracranial carotid artery. AJNR
1980;1:348–349
18. DeBakey ME, Crawford ES, Cooley DA, Morris GC Jr, Garrett
E, Fields WS. Cerebral arterial insufficiency. One to 11 years
result following arterial reconstructive operation. Am J Surg
1985;151:921–945
19. Dietrich EB, Garrett HE, Amerio J, Crawford ES, El-Bayer M,
DeBakey ME. Occlusive disease of the common carotid and sub-
clavian arteries treated by carotid subclavian bypass. Am J
Surg 1987;114:800–808
20. Imparato AM, Riles TS, Ecorstein F. The carotid bifurcation
plaque: pathologic finding associated with cerebral ischemia.
Stroke 1979;10:238–245
21. Fleming JRF, Deck JHN, Gotlieb AI. In: Smith RR, ed. Pathology
of atherosclerotic plaques in stroke and extracranial vessels.
New York: Raven 1984;23–37
22. Emery RW, Cohn LH, Whittemore AD, Mannick JA, Couch NP,
Collins JJ Jr. Coexistent carotid and coronary artery disease
WS. Comparative risk of operation and expectant management
1976;80:705–710
25. Hertzer NR, Martinez BD, Beven EG. Recurrent stenosis after
carotid endarterectomy surgery. Gynecol Obstet 1979;149:360–
364
Joint study of extracranial arterial occlusion cooperative study.
JAMA 1969;209:1889–1895
27. Brown OW, Kerstein MD. The surgical management of transient
ischemic attacks. Angiology 1984;35:12–21
28. Riles TS, Imparato AM, Mintzer R, Baumann EG. Comparison of
results of bilateral and unilateral carotid endarterectomy five
years after surgery. Surgery 1982;91:258–262
29. Loftus CM, Quest DO. Current status of carotid endarterectomy
30. Mullan S, Duda EE, Patro NAS. Some examples of balloon
31. Bockenheimer SAM, Mathias K. Percutaneous transluminal an-
gioplasty in arteriosclerotic internal carotid artery stenosis.
AJNR 1983;4:791–792
32. Belan A, Vesela M, Vanek I, Weiss K, Peregam JH. Percuta-
neous transluminal angioplasty of fibromuscular dysplasia of
the internal carotid artery. Cardiovasc Interv Radiol 1982;5:79–
81
33. Smith DC, Smith LL, Hasso AN. Fibromuscular dysplasia of the
internal carotid artery treated by operative transluminal balloon
34. Morris GC, Lechter A, DeBakey ME. Surgical treatment of fibro-
muscular disease of the carotid arteries. Arch Surg 1968;
96:636–643
35. Crawford ES, DeBakey ME, Morris GC Jr, Howell JF. Surgical
treatment of occlusion of the innominate, common carotid and
subclavian arteries. Surgery 1966;65:17–31
36. Beebe HG, Start K, Johnson ML, Jolly PC, Hill LD. Choices of
operation for subclavian-vertebral arterial disease. Am J Surg
1980;139:616–623