

Damage of the Brachiocephalic Vessels due to Catheterization*

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Summary. 14 cases (0.6%) of local damage to brachiocephalic arteries occurred during 2,300 consecutive femorocerebral angiographic studies. Improper manipulation of the catheter and guide wire, and wedging of the catheter, appeared to be the principal factors in the creation of intimal tears and subintimal hematomas. The use of J guide wires when feasible, careful fluoroscopic monitoring during the advancement of the guide wire catheter system, and test injections are advised. If an artery is damaged, the opposite artery of the same system should not be catheterized. No neurological sequelae resulted in these 14 patients.

Lésion iatrogène des vaisseaux brachio-céphaliques par catheterisation

Résumé. Les auteurs ont étudié 14 cas (0,6%) de lésion iatrogène au niveau des artères brachio-céphaliques survenues au cours de 2300 angiographies cérébrales par voie fémorale consécutives. Les facteurs essentiels à l'origine d'arrachement de l'intima et d'hématome pariétal semblent être une manipulation impropre du cathéter et du guide et la plicature du

cathéter. Il est recommandé d'utiliser des guides en "J" le cas échéant, le contrôle scopique télévisé soigneux durant la progression du guide et la mise en place du cathéter et de faire des injections tests. Si une artère est endommagée, il faut éviter de cathétériser l'artère contre latérale du même système. Il n'y avait aucune séquelle neurologique chez ces quatorze patients.

Iatrogene Schädigung der brachiocephalen Gefäße durch Katheterisierung

Zusammenfassung. Bei 2300 cerebralen Arteriographien über die A. femoralis kam es in 0,6% (14 Fälle) zu einer iatrogenen Gefäßschädigung. Dabei sind ungeschickte Manipulationen mit dem Katheter und mit dem Führungsdraht als Hauptursachen der Intima-Verletzung und der subintimalen Hämatome anzusehen. Es wird eine sorgfältige Durchleuchtungstechnik empfohlen, ferner werden Test-Injektionen vorgeschlagen. Bei Verletzung einer Arterie sollte die Arterie der Gegenseite nicht katheterisiert werden. Neurologische Ausfallserscheinungen blieben bei den 14 Patienten nicht zurück.

Complications during cerebral angiography cause concern among clinicians. When cerebral angiography was practiced exclusively by direct puncture of the carotid or vertebral arteries, the literature describing the complications was detailed and extensive. Currently, the catheter approach has largely replaced direct puncture technique [6, 12] in many centers, and reports have varied as to the safety of the procedure. Some consider the catheter technique to be very safe [12]; others consider it hazardous, especially in older and atherosclerotic patients [10]. The main dangers of this technique are considered to be thrombus formation in or on the catheter, and the possibility of fragmenting mural atherosclerotic plaques and thrombi by the guide wire or the catheter, both resulting in intracranial embolization [3, 9]. Intimal tears with resultant subintimal injections have long been recognized as a complication of direct needle puncture of the carotid and vertebral arteries. Little attention, however, has been given to this complication as a

result of catheterization of these vessels, [2, 4, 6, 7, 8, 11, 13].

Material and Method

2300 consecutive femorocerebral angiographic studies were reviewed and 14 cases of subintimal injections were discovered (Table 1). The examination technique applied was the same in all cases, employing end hole polyethylene catheters. The studies were performed with catheters made either from heavy walled pink tubing (B-D RPOX 047; O.D. 2, 18 mm; I.D. 1, 19 mm: 61/2 F) or thinwalled blue tubing (B-D) RPX 055; O.D. 1, 90 mm; I.D. 1, 400 mm: 6 F). All guide wires were teflon coated 0.88 mm (0.035 inches) or 0.97 mm (0.038 inches) in diameter with movable core and varying length of floppy end. All pressure injections were performed with a Medrad Mark II Injector. For common carotid injection, 8cc of contrast was injected at a rate of 10cc sec; for internal carotid injections, 8cc was injected at 8cc sec; for vertebral arteriograms, 6cc was injected at 8cc sec.

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Table 1. Data on patients and findings

Case	Name sex	Age	Diagnosis on admission	Vessel damaged by arteriography	Apparent cause of damage	Other arteriographic findings
1	R.F. M.	63	CVA with R. hemiparesis and aphasia	LCCA	Jet of contrast causing intimal tear	Occlusion of left internal carotid artery
2	E.L. M.	66	Nasopharyngeal car- cinoma; signs of in- creased intracranial pressure	RCCA	Jet of contrast causing intimal tear	None
3	J.M. M.	65	SAH	LCCA	Jet of contrast causing intimal tear	None
4	Ch.W. F.	35	SAH	RICA	Catheter wedged into intima	I.C. Aneurysm
5	A.W. F.	30	CVA with R. hemiparesis	LVA	Catheter wedged into origin of L. vertebral artery	None
6	N.W. F.	62	SAH	RCCA	Guide wire dissected beneath intima	I. C. Aneurysm
7	F.D. F.	42	SAH	LICA LVA	Guide wire dissected beneath intima	I. C. Aneurysm
8	S.R. M.	61	TIA	RICA	Catheter wedged into intima	None
9	O.L. F.	43	TIA	LVA	Catheter wedged into intima	None
10	E.E. M.	61	Cerebral tumor	RICA	Catheter wedged into intima	None
11	W.B. M.	41	SAH	RICA	Catheter wedged into intima	I.C. Aneurysm
12	E.L. F.	40	SAH	RICA	Catheter wedged into intima	I.C. Aneurysm
13	E.B. F.	70	Cerebral tumor	RCCA	Guide wire dissected beneath intima	None
14	A.W. F.	66	TIA	LVA	Jet of contrast causing intimal tear	Carotid stenosis

The technique employed has been described in detail elsewhere [12].

Discussion

In 1968, Lang [10] summarized the complications resulting from 11 402 cases of any type of angiography where the catheter approach was used. In his opinion the patients with atherosclerotic disease in advanced age groups appeared to sustain many intramural injections. He encountered 136 intramural or subintimal contrast injections (1.2%), all without sequelae. A possible danger of this type of complication mentioned by Lang is delayed embolism as the result of thrombus formation at the site of intimal damage.

Gilbert *et al.* [5], in 1965, studied the mechanism of formation of subintimal hematoma following retrograde arch aortography in the dog. Although the aortic arch is a comparatively large space where the pos-

sibility of whipping and impaction is much greater than in a much narrower tube such as a common or internal carotid artery, some of these conclusions can be applied to carotid angiography. He found that in each case of subintimal hematoma, medial dissection was also apparent microscopically. Injection pressure was clearly a critical factor in the production of subintimal hematoma. Two mechanical factors which tend to vary directly with injection pressure are the direct force of flow of the contrast medium against the vessel wall and the whipping of the catheter. The delivery of small injected volumes at high pressure did not appear to reduce these mechanical factors. He concluded that in order to reduce to a minimum the chance of a subintimal hematoma, the injection pressure has to be chosen at the lowest possible level capable of delivering sufficient contrast agent in the desired period of time. He made another very important observation in describing so-called "insertional excoriations", very small scratches and subintimal hematomas of the vessel walls related to the difficulties

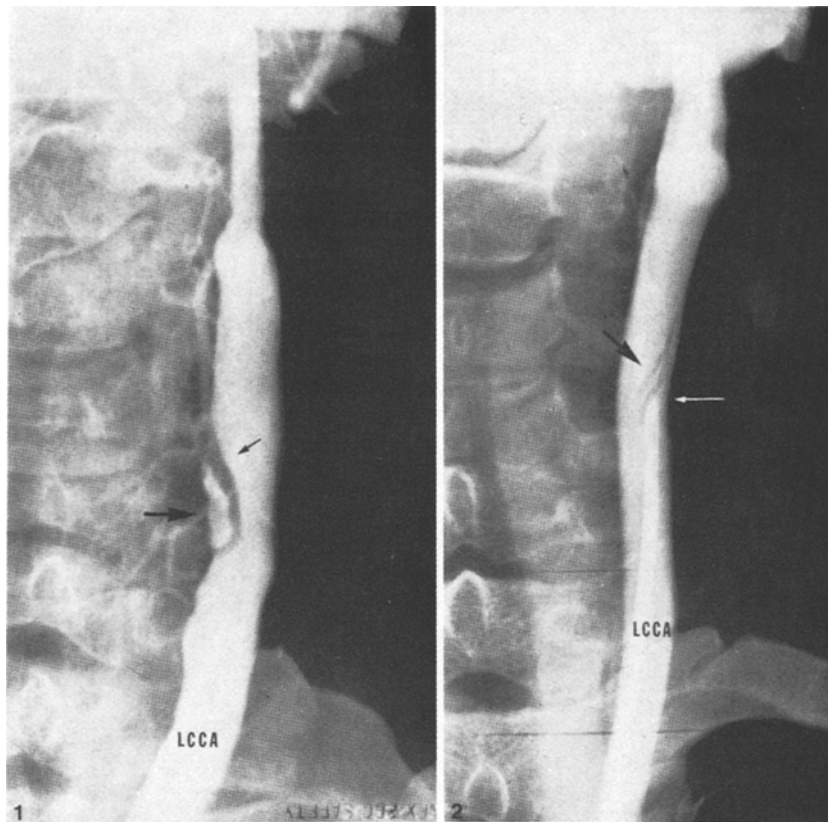


Fig. 1. Case 1. Left common carotid artery, AP view. Subintimal tear and dissection indicated by a large arrow. Small arrow shows the position of the tip of the catheter

Fig. 2. Case 3. AP view. Two lines of intimal tears indicated by a large arrow. Small arrow points to the tip of the catheter

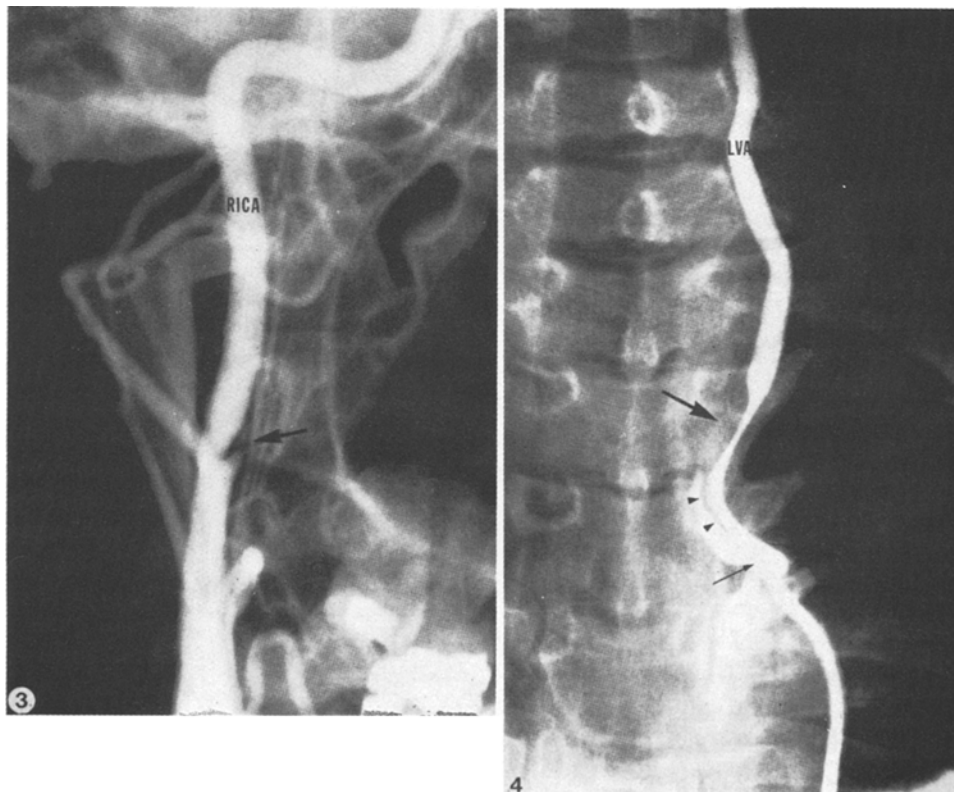


Fig. 3. Case 4. On the initial arteriogram the tip of the catheter had been placed in the right internal carotid artery at the C_2 level. Nine days later injection into the right common carotid artery (AP oblique view) shows an intimal tear (large arrow) on the right internal carotid artery where on previous angiographies the tip of the catheter was located

Fig. 4. Case 5. Left vertebral artery originating in the aortic arch. Subintimal tear (two arrowheads) and hematoma (large arrow) close to the tip of the catheter (small arrow)

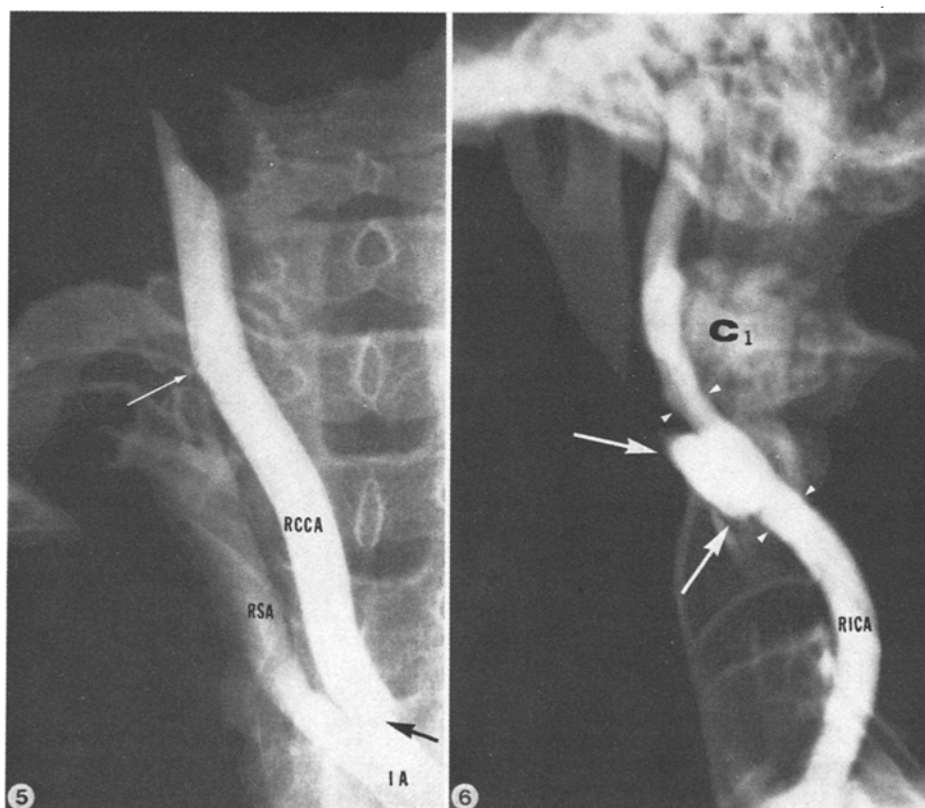


Fig. 5. Case 6. Dissection through the entire length of the right common carotid artery. Large arrow points to the proximal flange of the dissection, small arrow to the tip of the catheter. IA = innominate. RSA = right subclavian artery. Note the width of the carotid artery

Fig. 6. Case 11. Right internal carotid artery, lateral view. Large subintimal injection (large arrows). Note the difference in the width of the carotid artery below and above the subintimal hematoma (arrowheads)

in threading the catheter guide wire up the length of the aorta.

In 1971, Gibson [6] saw only one small dissection in 288 injected brachicephalic arteries following the advancement of a catheter up the common carotid artery without a guide wire beyond its tip. He advocated making a test injection after positioning the catheter and before the full injection.

The true incidence of subintimal injections and hematomas in catheter cerebral angiography is unknown. Certainly, it is much higher than has been thought. In many clinical studies, the catheter tip is not in the area filmed. This is always the case for vertebral angiography and sometimes for carotid angiography. We have tried to avoid this by always performing biplane single films of the extracranial portions of the carotid arteries. In vertebral angiography single films of the subclavian artery are made before and after the pressure injection. Probably, only larger subintimal tears and hematomas occurring during catheter cerebral angiography are detected by these techniques, while minute damages go undetected [5].

In our view the main cause of intimal damage is improper manipulation of the guide wire and catheter. We feel that the catheter should not be advanced into the vessel without the flexible tip of the guide wire protruding through; the sharp tip of the catheter in combination with its "natural" curve could easily damage the intimal layer and, in a small vessel, the possibility of wedging the catheter be increased (Figs. 3, 4, and 6). It is best first to advance the guide wire, then to slide the catheter over it. If any resistance is felt or seen during the advancement of the guide wire no substantial force should be applied (Fig. 5). The tip of the guide wire can easily penetrate the intima especially if the vessel is tortuous or of small caliber.

The combination of wedging and high speed of injection favors intimal damage (Figs. 2, 3, 4 and 6). Because the speed of the injection is a function of the pressure, one should "choose the lowest possible pressure capable of delivering sufficient contrast agent in the desired period of time" [5]. The maximum amount of contrast we inject into any brachiocephalic vessel (except innominate artery) is 10 cc; the maximum

flow rate into the common carotid artery is 10 cc/sec, and into the internal carotid and vertebral arteries 8 cc/sec.

To prevent a subintimal injection caused by wedging, the catheter should be withdrawn several millimeters before the pressure injection is performed, especially if a small vessel such as the internal carotid or vertebral artery is catheterized [7].

The atherosclerotic process is a pathological factor facilitating damage of the wall of the vessel (Fig. 1). When possible the use of a J guide wire is recommended to make dissection of the wire beneath an arteriosclerotic plaque less likely.

To determine whether the catheter is properly positioned, a hand injection of a small amount of contrast (2 ml), under fluoroscopy, should be performed [4, 6].

If in the course of catheter cerebral angiography a subintimal hematoma or dissection is produced in a carotid artery, the opposite vessel should not be catheterized [1]. The same is valid for vertebral artery studies.

It can be concluded that subintimal injections can occur with the catheterization technique in cerebral angiography. The occurrence of this complication is directly related to improper manipulation of the catheter and guide wire. However, we strongly feel that this in no way precludes the use of catheters. In this series no neurological sequelae resulted from the subintimal injections, and as far as could be ascertained, no occlusion of vessels resulted. On the basis of this experience, it would appear that surgical exploration of subintimal injections is not indicated.

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