

SUTURE/NON — SUTURE CIRCUMFERENTIAL REPAIR OF CAROTID ARTERY

By

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INTRODUCTION

Detailed technique and progress reports of nonsuture plastic adhesive repairs in blood vessels, intestines, ureters and bronchi have been published by Healey and his associates (3,4,5,6). The adhesive has been satisfactorily tolerated by these tissues; however, due to variations in its chemical structure, a comparative study with collection of additional data seemed necessary. This series utilized three plastic adhesives and 5-0 arterial silk in circumferential carotid artery repairs in canines (Table I).

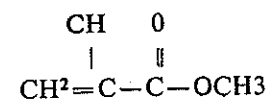
MATERIALS AND METHODS

The specific plastic adhesives used in this project were: 1) M2C-2 (methyl 2-cyanoacrylate monomer), 2) IBC-1 (isobutyl cyanoacrylate monomer) and 3) NBC-1 (normal butyl cyanoacrylate monomer).*

Chemistry of methyl 2-cyanoacrylate monomer: The adhesive action of M2C-2 was discovered by Coover et al (2) during an investigation of a series of polymers derived from 1, 1-disubstituted ethylenes. A drop of highly purified methyl 2-cyanoacrylate was placed between the discs of an Abbe refractometer in order to obtain its refractive index for comparison with that of a previously prepared sample. When an attempt was made to open the refractometer, the discs could not be pulled apart. As a result of this discovery, the properties of the 1,

* Supplied by Ethicon, Incorporated

1-disubstituted ethylene adhesives were studied. The chemical structure of methyl 2-cyanoacrylate is:



Isobutyl cyanoacrylate monomer and normal butyl cyanoacrylate monomer are higher homologues of the same alkyl 2-cyanoacrylate group.

Randomization: An accurate estimation of reaction at individual repair sites was impossible if more than one repair was assessed to one artery. With this in mind, bilateral carotid repairs were done in two dogs to accomplish a complete set of the four available repairs for each specified biopsy time. Rather than have the same two repairs consistently appear together as bilateral partners, a randomized schedule, which included all possible variations of the four materials, dogs weighing 13.7 kg. to 25.0 kg. were used. This resulted in a total of 48 circumferential anastomoses, twelve with 5-0 silk suture and twelve with each respective plastic adhesive. The biopsy times were programmed for one year, appointing the earliest repair to the longest biopsy time.

Technique: Bilateral 4-6 cm. incisions were made on the neck; the external jugular veins were retracted laterally and the sternocleidomastoid muscles medially. The carotid sheaths were incised and 4-5 cm. of the carotid arteries were isolated. Approaching each side separately, Bulldog clamps were applied to the artery proximal and distal to the intended anastomosis. A special instrument designed by Healey et al (7) and referred to as an "anastomat" was placed on the vessel. The artery was transected, each side swabbed and carefully everted over its respective half of the anastomat, and the everted cuff pinioned with a rubber O-ring. The two halves of the anastomat were approximated and the Bulldog clamps removed, thus establishing a rapid recirculation through the transected vessel. The O-rings were then cut and removed, exposing the everted lumens to be anastomosed with the appropriate (Fig 2).

Arteriograms: This paper is based on findings established primarily from arteriograms (Figs. 3, 4) and the gross reactions of several of the shorter term specimens. An evaluation of the histological findings will be submitted upon completion of the longer term biopsies.

Arteriograms have been done on all animals in this series, either by direct cannulation of the carotid arteries as in those already biopsied, or by insertion of a catheter via the femoral vein into the arch of the aorta as in those awaiting long-term biopsy. Renografin "60" was used as a contrast media.

RESULTS

Of the 48 dogs used this series, there was no mortality. One animal developed postoperative leak at six days in the artery anastomosed with methyl 2-cyanoacrylate monomer. Consequently it was used as the one week specimen.

Although aseptic techniques were not as stringently pursued as those in regular operating rooms, no difficulty in wound healing or infection was encountered. All animals were treated for two weeks postoperatively, on alternate days, with 2 cc Longicil-S (a longacting penicillin) and skin sutures were removed within 10 days. The area was cleansed with H₂O₂ and sprayed with a topical application of Furoxone at that time.

As evidenced by arteriograms performed at various intervals ranging from one week to five months, of the twelve anastomoses done with normal butyl cyanoacrylate monomer, only two were thrombosed; of twelve anastomoses with isobutyl cyanoacrylate monomer, again only two were thrombosed; of twelve anastomoses with 5-0 silk suture, three were thrombosed; and of the twelve done with methyl 2-cyanoacrylate monomer, nine were thrombosed. Of the total of 48 repairs, 17 were methyl 2-cyanoacrylate monomer repairs. No anticoagulant was administered to the animals in the series.

DISCUSSION

In this and other studies (1, 8) a rapid and effective method of nonsuture anastomosis of the carotid artery, circumferential or linear, has been established. Of particular importance in the repair of small vessels is the absence of a decrease in the size of the lumen. This study revealed a significant difference in the applied physiological adhesives, especially between the two higher homologues and the methyl 2-cyanoacrylate monomer. However, to a lesser degree, these two also presented better results than the 5-0 silk suture anastomoses.

In most of the arteriograms it is difficult to identify the repair site. Gross examination of biopsies so far completed exhibit minimal intramural clots.

The absence of mortality due to hemorrhage is indicative that no necrosis of arterial walls occurred as a result of physiological adhesive application. Minimal amounts of adhesive result in excellent bonding and present less tissue reaction. Thrombosis and failure of repair in this study may obviously be attributed to excessive applications of adhesive. On a rare occasion the initial repair failed and the vessel had to be shortened and re-anastomosed. One such repair was that with delayed postoperative hemorrhage at six days. Carotid arterial lumens are small and extensive care is necessary to prevent adhesives from entering them or thrombosis will inevitably ensue.

LEGEND

Figure 2. Technique for circumferential repair. A, ends of vessel everted over rings of clamp and secured in position by rubber O-rings. O-rings being cut; B, everted cuffs dried; C, plastic applied; D, cuffs brought into apposition and polymerization initiated by pressure; E, shanks of anastomat opened; F, clamp removed from vessel. (Courtesy of John E. Healey, Jr.; American Journal of Surgery, 109:416-423, 1965)

Figure 3. Bilateral carotid arteriograms. A, 4½ months post repair right side, IBC-1, left side, NBC-1; B, 5 months post repair-right side, M2C-2, left side, IBC-1.

Figure 4. Bilateral carotid arteriogram. 5 months post repair right side, suture, left side, IBC-1.

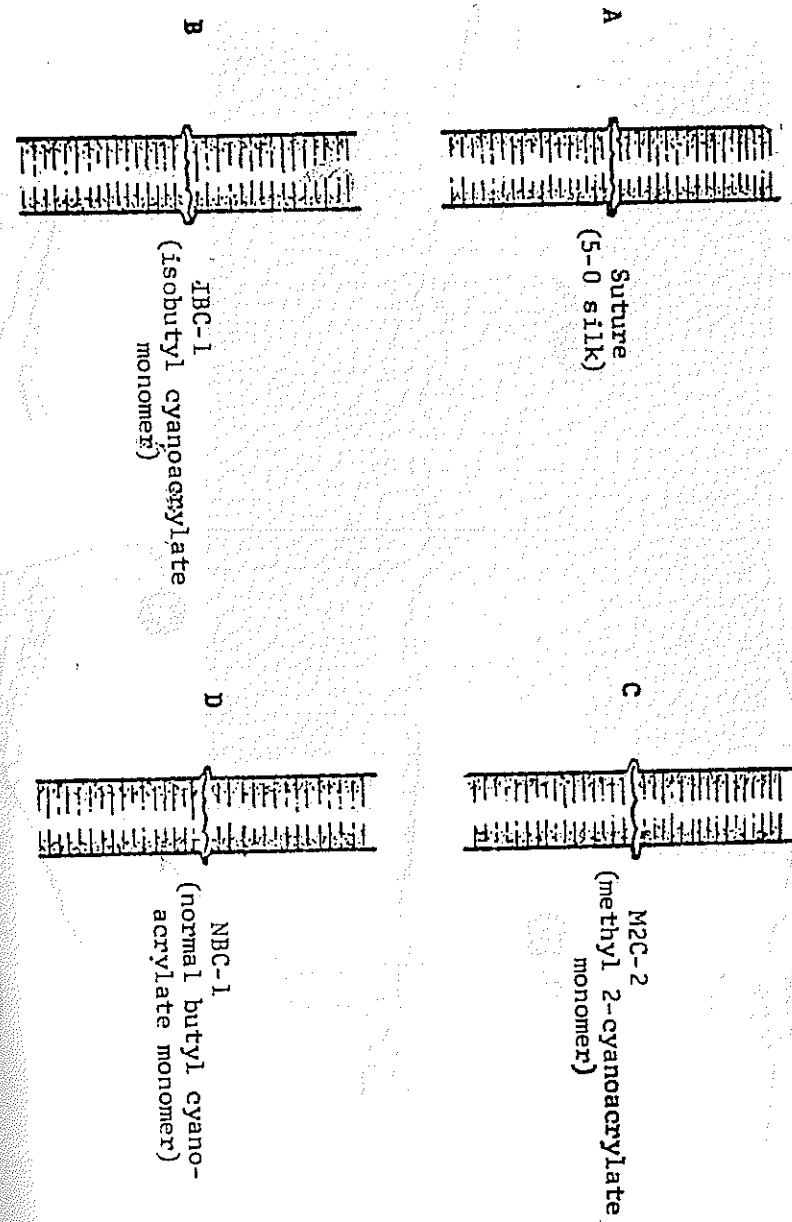
Table 1

Circumferential Common Carotid Repairs *

Applications and Number	Leakage Requiring Sutures	Hemorrhage	Thrombosis	Failures Per Cent
NBC-1	12 0	0	2	16.6
IBC-1	12 0	0	2	16.6
5-0 Silk	12 0	0	3	25
M2C-2	12 0	1+	8	75

* No infection and no anticoagulant used.

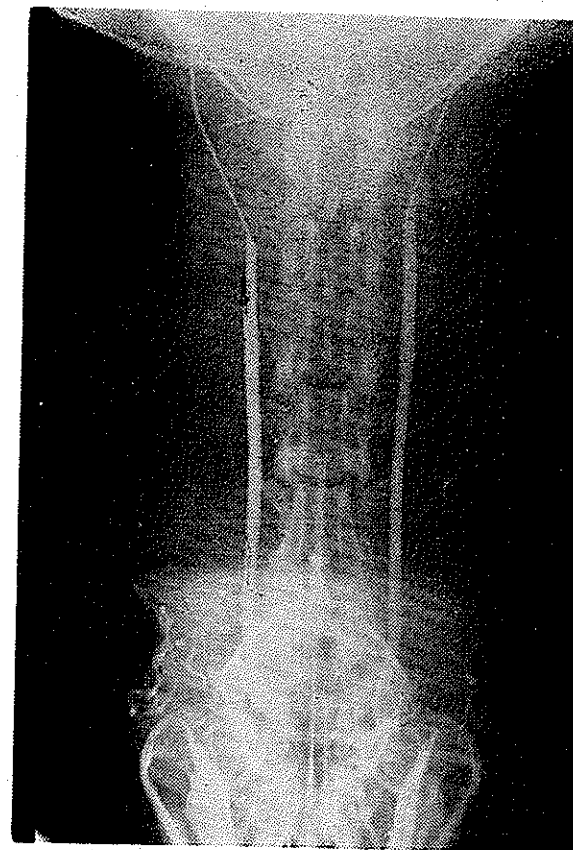
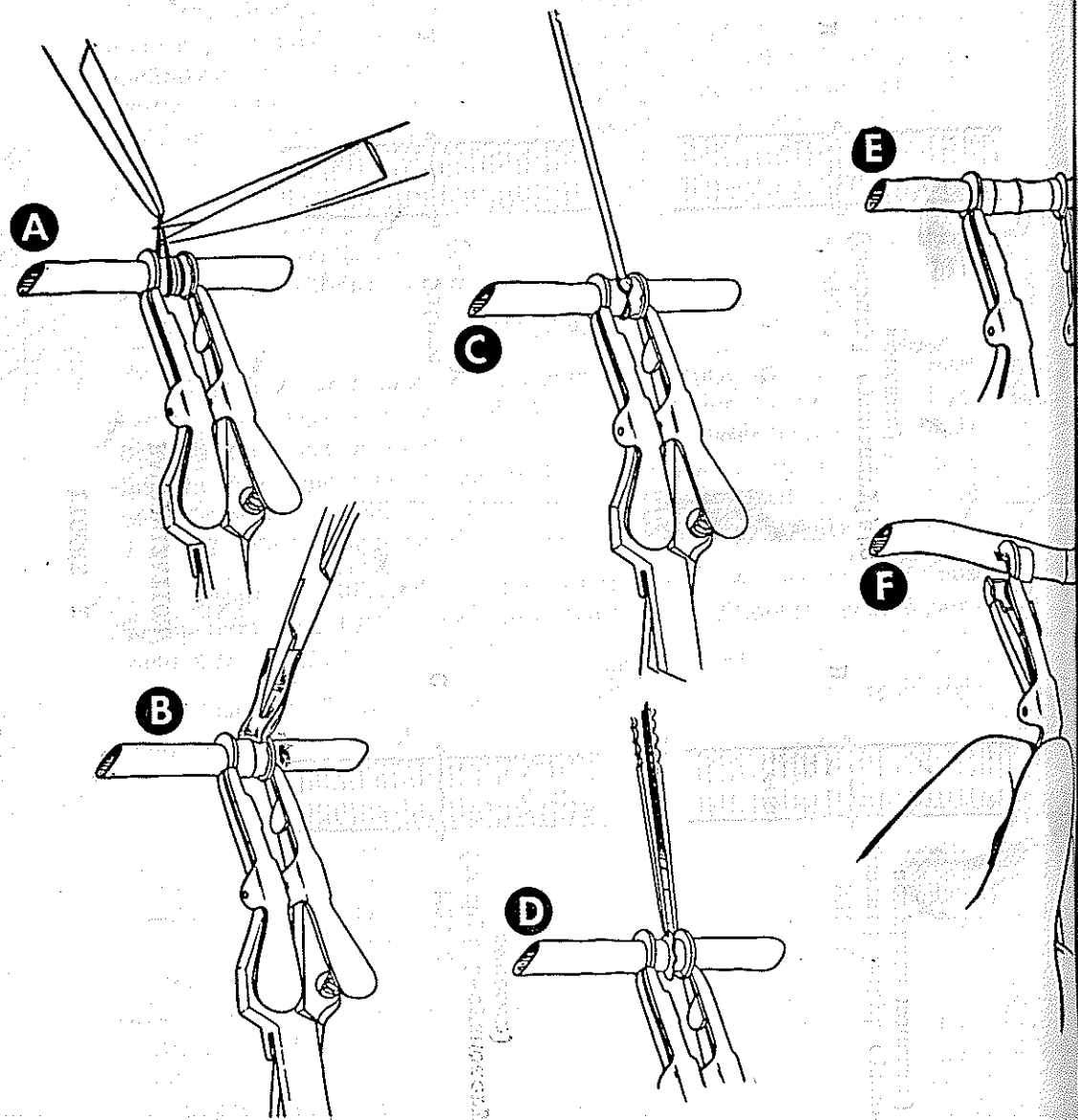
+ Delayed hemorrhage six days postoperative.



RANDOMIZATION

FIGURE I

FIGURE 2



Summary

Three plastic adhesives, normal butyl cyanoacrylate monomer, isobutyl cyanoacrylate monomer and methyl 2-cyanoacrylate monomer, have been utilized in a comparative study with 5-0 silk suture in the repair of transected carotid arteries. Follow-up arteriograms indicate isobutyl cyanoacrylate monomer and normal butyl cyanoacrylate monomer as having the most impressive results with only two thrombosis each. The silk suture had three thromboses and the adhesive methyl 2-cyanoacrylate monomer had nine, one of which a delayed six day postoperative leak.

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