

Phlebitis from Plastic Intravenous Catheters

Frederick W. Cheney, Jr., M.D., and John R. Lincoln, M.D.

In a study of 135 cases, the incidence of phlebitis following intravenous therapy with plastic catheters was 47 per cent. The incidence of phlebitis and local tissue reaction increased with the length of time the catheter was left in place. All catheters were cultured on withdrawal and 9.7 per cent were positive for pathogenic bacteria. Evidence is presented to suggest that the etiology of the phlebitis is mechanical rather than bacterial.

THE NEED for prolonged intravenous therapy has resulted in the introduction of techniques by which plastic catheters are inserted into superficial veins. In spite of advantages, many complications have been attributed to the use of these catheters,^{1,2,3} the most common being thrombophlebitis and cellulitis. In most studies the incidence of phlebitis varied directly with the length of time catheters were in place.⁴⁻⁷ Several authors have indicated bacterial contamination as the cause, although no figures were given to support this view.^{5,7,8} The frequent occurrence of phlebitis and local inflammation from plastic intravenous catheters in our patients stimulated a study to determine the incidence and causes of this phenomenon.

Materials and Methods

One hundred and thirty-five patients who were undergoing elective surgical or diagnostic procedures requiring anesthesia were studied. Bard (No. 1514) Intracath plastic catheters, 18 gauge, 8-12 inches in length were inserted prior to induction of anesthesia. The skin was prepared with aqueous benzalkonium (Zephiran) 1:750 and the catheter inserted through a 14 gauge needle. Since these catheters are supplied in sterile plastic sheaths, sterile gloves and draping were not employed. A coded ointment containing either 3 per cent tetracycline (Achromycin) or a placebo was placed

over the puncture site in 105 patients. Before the study was begun, Achromycin ointment was placed over the puncture site in 20 patients and no ointment was used in 10 cases. The puncture site was then covered with sterile gauze and the Intracath taped securely in place. Most catheters were inserted in the basilic or cephalic veins. Other sites were the veins of the forearm and, rarely, the saphenous vein at the ankle.

The catheters remained in place after operation and were removed by an attending or resident anesthesiologist. A record was kept of solutions infused, concomitant systemic antibiotic therapy, length of time each catheter was in place and grade of reaction when removed. Before the catheter was withdrawn, the skin surrounding the puncture site was prepared with 70 per cent alcohol. After this dried, the catheter was withdrawn with sterile forceps and the terminal 3 to 5 inches cut with sterile scissors and placed in 10 ml. of thioglycolate broth. This was incubated at 37° C. for 72 hours, unless evidence of bacterial growth became manifest sooner. Tubes which showed turbidity were subcultured on blood agar plates. Coagulase tests were done on cultures growing staphylococci. Patients who showed no reaction at the time of catheter removal were re-examined 24 hours later and any change in reaction was noted.

For the purposes of reporting, the patients are divided into those who had Achromycin ointment applied and those who did not. The reactions are classified as grade A—no reaction or slight erythema around the site of entrance of the catheter; or grade B—significant superficial phlebitis associated with cellulitis, tenderness or painful thrombosis of the vein. The reactions listed are those noted 24 hours after withdrawal of the catheter.

Results

The number of grade B reactions was 63, an incidence of phlebitis of 47 per cent.

Accepted for publication April 8, 1964. Dr. Cheney is Resident Anesthesiologist, and Dr. Lincoln is Director, Department of Anesthesiology, Maine Medical Center, Portland, Maine.

In 21 patients the reactions had converted from grade A to B reactions when the 24 hour post-withdrawal visit was made.

Achromycin ointment failed to reduce the incidence of phlebitis from plastic intravenous catheters. The incidence of grade B reactions in patients who had Achromycin ointment was 42 per cent, and in patients who had a placebo or no ointment, 47 per cent. The statistical difference between these groups is insignificant. There was a sharp increase in the incidence of grade B reactions after the catheters were in place over 24 hours (table 1). Systemic antibiotic therapy while the catheters were in place had no effect on the grade of reaction.

The type of bacteria present in the positive cultures and the average time the infected catheters were in place are listed in table 2. *Bacillus subtilis* is a common dust contaminant, so three cases from which it was cultured were considered negative for pathogens. This gave an incidence of 9.7 per cent (13 of 135 cases) positive cultures for bacteria which are potentially pathogenic.

There was little correlation of positive cultures to phlebitis. Six of the 13 patients had no reaction. Of the seven patients who had a grade B reaction, four developed it after catheter removal. Thus, at the time the catheter was removed, 10 of 13 patients with positive cultures had no evidence of phlebitis.

Achromycin ointment did not decrease the incidence of positive cultures. Seven of the 13 patients with positive cultures had received Achromycin ointment. Patients who received concomitant systemic antibiotic therapy had a decreased incidence of positive cultures. Two of 42 patients on systemic antibiotics had positive cultures—an incidence of 5 per cent. The remaining 11 positive cultures comprised

TABLE 1. Incidence of Grade B Reactions Related to the Length of Time the Plastic Catheter Was in Place

| Hours Intracath in place | 0-24 | 24-48 | 49-72 | over 72 |
|-----------------------------------|------|-------|-------|---------|
| Total number of cases | 43 | 40 | 38 | 14 |
| Number with grade B reactions | 4 | 23 | 28 | 8 |
| Percentage with grade B reactions | 9% | 58% | 74% | 57% |

TABLE 2. Type of Bacteria Present in Positive Catheter Cultures and the Average Length of Time the Catheter Was in Place

| Bacteria Present in Positive Cultures | Cases | Average Number of Hours in Place |
|---------------------------------------|----------|----------------------------------|
| Alpha streptococcus | 1 | 8 |
| Staph. coagulase positive | 1 | 52 |
| <i>Bacillus subtilis</i> | 3 | 72 |
| Staph. coagulase negative | 11 | 72 |
| Total | 16 cases | |

12 per cent of the 93 patients who received no systemic antibiotics. Each patient with a positive culture was carefully followed and none exhibited clinical evidence of septicemia, fever, septic emboli or local abscess formation. Phlebitic and local tissue reactions cleared in three to four days with only the application of hot packs, whether patients had positive or negative cultures.

In no case did abscess formation, slough or known embolic phenomena occur. After grade B reactions had subsided, the involved veins of most patients had completely thrombosed.

Most solutions infused were normal saline, 5 per cent dextrose in water, and blood. No relation could be detected between the grade of reaction and type of solution infused.

Discussion

Various means have been suggested for decreasing the incidence of reactions from plastic intravenous catheters. The use of collodion, bacitracin ointment or flamed tape at the site of the skin opening⁷; hydrocortisone, 10 mg. per liter of infused fluid⁸; and streptomycin, 5 μ g. per milliliter of infused fluid,¹⁰ are of no value in preventing phlebitis. Heparin, 10 mg. per liter of intravenous solution, causes no systemic effects¹¹ and has been reported as effective by some,^{7,11} and ineffective by others.¹²

Phillips and Eyre⁸ have suggested that septic phlebitis may occur because the plastic catheter does not fit tightly in the skin puncture, and microorganisms may enter the wound as the patient moves his arm, sliding the catheter back and forth. This might explain the staphylococcus, coagulase negative cultures in our study. A single application of 3 per cent

Achromycin ointment does not nullify this effect.

Although some catheters stayed in place for as long as 144 hours without causing a reaction, this was exceptional. When erythema was noted along the course of the vein while the catheter was in place, the patient developed pain, cellulitis, and thrombosis in the ensuing 24 hours unless the catheter was promptly withdrawn.

The finding of positive cultures in some patients who had no visible skin reaction, and the low incidence of positive cultures among those who had grade B reactions in this study would seem to indicate that the phlebitis and cellulitis associated with plastic intravenous catheters is mechanical, rather than bacterial in origin.

The low incidence of positive cultures in this study may have been due to the fact that the catheters were inserted in an operating room, and to the presumed absence of infection in our patients, all of whom were undergoing elective surgery. Druskin and Siegel,¹³ in a study of 54 cases, reported a 40 per cent incidence of positive cultures, but the catheters were inserted in a medical ward in critically ill patients. These authors found no relation between the incidence of phlebitis and positive cultures.

Summary

Plastic intravenous catheters are useful adjuncts in parenteral therapy, but complications may result from their use. Of 135 patients in whom plastic catheters were employed, none developed major complications, but 63 developed phlebitis associated with pain, cellulitis or painful thrombosis. The incidence of these reactions was low for patients whose catheters were in place less than 24 hours, but thereafter increased in proportion to the length of time the catheter was left in place. A single application of 3 per cent Achromycin ointment had no effect on the incidence of either positive cultures or observed reactions. Our studies strongly suggest mechanical factors, rather than infection, as the etiology of these reactions. Cultures were made from all catheters. None of the 13 patients who had

positive cultures showed evidence of systemic infection.

Preliminary report presented at the Work in Progress program of the Annual Meeting of the American Society of Anesthesiologists, Chicago, November 5, 1963. (Abstract: *ANESTHESIOLOGY* 25: 92, 1964.)

References

1. Turner, D. D., and Sommers, S. C.: Accidental passage of a polyethylene catheter from cubital vein to right atrium, *New Engl. J. Med.* 251: 744, 1954.
2. Trusler, G. A., and Mustard, W. T.: Intravenous polyethylene catheter successfully removed from the heart, *Canad. Med. Ass. J.* 79: 558, 1958.
3. Scharf, F. L., Bergman, B. J., and Cleveland, E. M.: Some complications in the use of indwelling intravenous polyethylene catheters: report of five cases, *Medical Serv. J. Canada* 17: 724, 1959.
4. Anderson, L. H.: Venous catheterization for fluid therapy, *J. Lab. Clin. Med.* 36: 645, 1950.
5. Bogen, J. E.: Local complications in 167 patients with indwelling venous catheters, *Surg. Gynec. Obstet.* 110: 112, 1960.
6. Alexander, E., Small, W., and Campbell, J. B.: A dependable method for constant intravenous therapy in infants using polyethylene tubing, *Ann. Surg.* 127: 1212, 1948.
7. Erwin, P., Strickler, J. H., and Rice, C. O.: Use of polyethylene tubing in intravenous therapy for surgical patients, *Arch. Surg.* 66: 673, 1953.
8. Phillips, R. W., and Eyre, J. D.: Septic thrombophlebitis with septicemia: report of three cases due to staphylococcus aureus infection after the intravenous use of polyethylene catheters for parenteral therapy, *New Engl. J. Med.* 259: 729, 1958.
9. Clark, P. B., and Polak, A.: A clinical trial of hydrocortisone in the prevention of transfusion thrombophlebitis, *Postgrad. Med. J.* 36: 55, 1960.
10. Hugh-Jones, K.: Local complications in intravenous therapy, *Great Ormond St. J.*, June 1954, pp. 43-55.
11. Anderson, L. H., Aldrich, S. L., Halpern, B., and Dolkart, R. E.: Venous catheterization for continuous parenteral therapy (use of heparin in delaying thrombophlebitis), *J. Lab. Clin. Med.* 38: 585, 1951.
12. Moncrief, J. A.: Femoral catheters, *Ann. Surg.* 147: 166, 1958.
13. Druskin, M. S., and Siegel, P. D.: Bacterial contamination of indwelling intravenous polyethylene catheters, *J.A.M.A.* 185: 966, 1963.