

LOCAL HYPOTHERMIA OF THE URINARY BLADDER DURING TRANSURETHRAL SURGERY

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Blood vessels constrict when exposed to cold. For ages people have used ice to stop bleeding from wounds. In modern surgery, however, this fact has been largely ignored. In fact, when compresses are applied during an operation, time-honored custom dictates that they be warm. One type of operation in which local cold may be beneficial is the transurethral resection of prostate and bladder tumors.

Recently Landes¹ reported on a series of patients in whom a refrigerated solution was used for irrigation of the bladder in transurethral operations. He was impressed with the diminution of bleeding during and after the operative procedures and failed to find any apparent ill effects from the use of the cold solutions.

The purpose of the present study was to further evaluate the use of cold in patients undergoing transurethral resection of prostate or bladder tumors. The results of irrigating the bladder with refrigerated solutions was compared with those obtained when room temperature solutions were used. Primary emphasis was placed on observed temperature changes and interpretations of these changes. Observations concerning blood loss were also made and will be reported. A detailed study of the amount of bleeding, determined by blood volume studies and estimation of blood lost in irrigating solution was also made but will form the basis of a subsequent report and will be only briefly mentioned here.

Up to the present time we have used the cold irrigating solution in over 150 cases and have used as controls for comparison an equal number of cases irrigated with room temperature solutions. Detailed temperature studies were performed only on the 52 cases included in this report.

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METHOD

The 52 patients studied ranged in age from 42 to 81 years and were rated according to risk as Class II or III according to the classification of the American Society of Anesthesiologists. Most of the patients had coexisting pulmonary or cardiovascular disease of varying severity. The surgical condition in all instances was benign or malignant disease of the prostate or urinary bladder.

Spinal anesthesia was used in all instances. Premedication varied but in general consisted of an anticholinergic agent plus a narcotic and either a barbiturate or promethazine. Patients were awake and responsive during the operation in all cases.

Room temperature ranged from 22 C. to 24 C. The irrigating solutions were either water or Sorbital. In the 12 control cases the solutions were at room temperature. In the 40 cases in which cold irrigating solutions were used, the temperature of the solution ranged from 0 C. to 15 C., with the usual temperature between 2 C.-6 C. The solutions (2-3 l.) for irrigation were prepared in the usual manner and placed in a refrigerator (2-6 C.) adjoining the operating room the night before operation.

The temperatures were recorded with Electro-Medical thermistors which were frequently checked for accuracy. Two leads were used, one placed 5-8 cm. into the rectum, the other inserted into the esophagus to the mid-heart level. The lower esophageal position is considered to be the most reliable site for determining true body core temperature.² Inserting the semi-rigid esophageal lead into the nose of an awake patient proved to be no more disturbing than inserting a naso-gastric tube. To reduce irritation, the nasal mucosa was sprayed with 10 per cent cocaine several minutes prior to insertion. In the event that gagging or retching occurred, the administration of the spinal anesthetic was delayed until this ceased. The presence of the semi-rigid thermistor lead in the rectum did not disturb

TABLE 1
TEMPERATURE CHANGES IN DEGREES CENTIGRADE OBSERVED IN PATIENTS DURING
IRRIGATION OF BLADDER

	Range of Fall of Rectal Temperature	Mean Fall of Rectal Temperature	Lowest Rectal Temperature Reached	Range of Fall of Body Core Temperature	Mean Fall of Body Core Temperature	Lowest Body Core Temperature Reached
Irrigated with cold solutions	0.3-14.9	4.4	22.2	0.1-2.7	1.1	33.8
Controls	0.4-3.4	1.5	33.3	0.2-1.2	0.7	34.9

the surgeon, and only once was it inadvertently pulled out.

The temperatures were recorded at five-minute intervals throughout the operation and during the time spent in the recovery room.

Irrigation of the bladder with cold solution continued only for the duration of the operation, and no effort was made to keep the bladder full of cold solution in the post-operative period.

RESULTS

As shown in table 1, the fall in rectal temperature in the cases irrigated with cold solution ranged from 0.3 to 14.9 degrees centigrade. The mean fall in the 40 cases was 4.4 degrees centigrade, and the lowest rectal temperature recorded was 22.2 C. The fall in body core temperature in these cases ranged from 0.1 to 2.7 degrees centigrade. The mean fall in the 40 cases was 1.1 degrees centigrade, and the lowest body core temperature seen was 33.8 C.

In the control series irrigated with room temperature solution the fall in rectal temperature ranged from 0.4 to 3.4 degrees centigrade. The mean fall in these 12 cases was 1.5 de-

TABLE 2
TEMPERATURE CHANGES RELATED TO THE
TEMPERATURE OF THE IRRIGATING
SOLUTIONS

	Degrees Centigrade			
	0-3	3-6	6-15	22-24
Temperature of irrigating solutions				
Mean fall in esophageal temperature	1.1	1.1	0.9	0.7
Mean fall in rectal temperature	5.1	5.2	1.6	1.5

grees centigrade and the lowest rectal temperature seen was 33.3 C. The fall in body core temperature in the control series ranged from 0.2 to 1.2 degrees centigrade. The mean fall in the 12 cases was 0.7 degree centigrade, and the lowest core temperature was 34.9 C.

Both the rectal and esophageal temperatures returned slowly to pre-irrigation levels, in many instances requiring from 3 to 5 hours.

The use of colder solutions results in greater fall in both rectal and body core temperatures as might be expected (table 2).

TABLE 3
TEMPERATURE CHANGES IN DEGREE CENTIGRADE
DURING IRRIGATION WITH COLD SOLUTIONS
RELATED TO OPERATIVE RISK

	ASA Class II	ASA Class III
Mean fall in esophageal temperature	0.9	1.4
Mean fall in rectal temperature	3.8	5.2

The data in table 3 indicate that patients who were in poor general health had greater reductions in both rectal and body core temperature as a result of irrigation with cold solutions. As seen from table 4 there was no consistent pattern with respect to age.

From a study of the individual temperature charts it was observed that generally both temperatures continued to fall as long as irrigation with cold solution continued. After the end of irrigation the esophageal temperature usually drifted downward a fraction of a degree before starting to return to normal. The rectal temperatures on the other hand began to increase as soon as bladder irrigation stopped.

TABLE 4
CHANGES IN TEMPERATURE (DEGREES CENTIGRADE)
DURING IRRIGATION WITH COLD SOLUTIONS
RELATED TO AGE OF PATIENT

	Age 51-60	Age 61-70	Age 71-80
Mean fall in esophageal temperature	1.1	1.1	1.2
Mean fall in rectal temperature	2.0	4.5	3.0

Of the 40 patients in which cold irrigating solutions were used, there were 8 with a marked fall in rectal temperature (table 5). These 8 cases were all characterized by the occurrence of surgical complications. Five of these 8 patients (7, 11, 25, 29 and 38) had presumptive evidence of direct venous absorption of large volumes of cold irrigating solutions via open venous sinuses at the operative site. In patients 12 and 40 there was a bladder perforation with cold fluid entering the peritoneal cavity. In patient 22 there was excessive arterial bleeding necessitating the transfusion of two units of blood. One additional patient had clinical evidence of absorption of cold irrigating solution into the venous sinuses without the expected fall in rectal temperature, but in the recovery room the rectal thermometer was discovered to be embedded in fecal material. It was interesting that in the patients with surgical complications where the rectal temperature fell markedly there was no consistent change in the body core temperatures, the falls ranging from 0.3 to 2.5 degrees centigrade.

In the control series there were two instances of bladder perforation and two instances of apparent venous absorption of irrigating solution. There were no marked temperature changes in these patients as there were when the cold solutions were used.

Several instances of transient cardiac irregularities were seen, consisting of premature ventricular contractions and premature atrial contractions and one instance of atrial fibrillation. These could not be related to the lowered temperature, and were seen equally as often in the control cases. They were better related to complicating cardiovascular disease.

Patient 22, who bled excessively, shivered and complained of being cold during the study. During the time that he felt cold he also showed other signs of shock, hypotension, pallor and cold clammy skin. All of these signs disappeared after transfusion.

DISCUSSION

Since true body temperature does not appear to be appreciably affected by the use of cold irrigating solutions, we do not believe it necessary to continue to record esophageal temperatures in these cases.

Rectal temperatures on the other hand may fall markedly during the procedure when using cold irrigating solutions. While it would seem that the location of the thermistor lead close to the chilled bladder would account for this drop in rectal temperature, a more satisfactory explanation is evident. Bazett and associates³ stated that cooled venous blood from the pelvic organs flowing up the internal iliac veins is rapidly warmed by a transfer of heat from the

TABLE 5
TEMPERATURE CHANGES (DEGREES CENTIGRADE) IN PATIENTS WITH SURGICAL COMPLICATIONS

Patient	Lowest Rectal Temperature	Reduction in Rectal Temperature	Lowest Esophageal Temperature	Reduction in Esophageal Temperature	Temperature of Irrigating Solution Used
7	27.8	8.7	33.8	1.7	4-8
11	30.3	8.4	35.5	0.4	0-4
12	28.5	9.6	34.0	2.5	0-4
22	27.2	9.3	34.6	1.9	2-8
25	23.8	13.4	35.7	0.3	3-6
29	27.8	10.1	34.6	1.4	3-7
38	28.3	9.3	35.5	1.6	0-4
40	22.2	14.9	34.0	2.2	3-6

internal iliac arteries which are in close proximity to the veins. The arterial blood having lost heat reaches the pelvic area, including the rectum, and absorbs heat from the tissues which it supplies. The result is a fall in tissue temperature of the entire pelvic region and the thermistor lead in the rectum records this. When cold irrigating solution is introduced directly into the veins the fall in rectal temperature is even more marked indicating that this heat exchange between arteries and veins takes place to a greater degree when this happens. The fact that the body core temperature falls very little even in this situation indicates that this mechanism for the conservation of body heat is most efficient.

We believe that monitoring the rectal temperature, while not essential, would prove valuable in warning of intravenous infusion of cold irrigating solution. The usual indication of direct intravenous infusion of irrigating solution is a sharp rise in blood pressure and may not occur until a dangerously large amount of solution has been absorbed. When cold solutions are used, the precipitous fall in rectal temperature may precede this blood pressure change by from 15-30 minutes and thus could provide a valuable warning to the anesthesiologist and to the surgeon. In several instances in our study, the anesthesiologist was able to advise the surgeon of probable surgical complication earlier than would have otherwise been possible, thereby enabling the surgeon to take measures to prevent more extensive damage to the patient.

Preoperative enemas should be given routinely in order to avoid fecal material covering the thermistor as occurred in one of our patients. Occasionally these will not be effective, but generally they result in more accurate rectal temperatures.

A preliminary examination of the blood loss studies in progress* suggests that the blood loss in transurethral surgery is much less when

* In all cases the blood lost during surgery was determined by measuring the amount of hemoglobin in an aliquot of the irrigating solution collected in a barrel, arriving at the total amount of hemoglobin in the barrel by determining the total amount by weight of irrigating solution used. In many cases patient's blood volumes were determined by the RISA method before surgery and 24 hours after surgery.

cold irrigating solutions are used. Of possible greater significance are the observations of the operating surgeons. They state that the diminished bleeding provides them with a clearer operating field and has resulted in shorter operating time and diminished incidence of operative complications. The reduction of postoperative bleeding is evident to everyone on the Urologic Service, especially to the ward doctors. They rarely have to spend the night irrigating bloody plugged catheters since we have started using cold irrigating solutions. Also, returning a patient to surgery for fulguration of bleeding points after a transurethral resection is now a rare occurrence compared to our experience in previous years when it was quite common. These observations have not been evaluated statistically, but they can be accepted as evidence that the bleeding both during and after the operation is notably reduced as a result of using cold irrigating solutions.

Initially the surgeons were bothered by the coldness of the irrigating solution, but since they have become acclimated they no longer complain and they believe that the benefits obtained outweigh the minor discomforts.

SUMMARY AND CONCLUSIONS

The use of cold solutions for irrigating the bladder during transurethral resection of prostate and bladder tumors was evaluated in forty patients and compared with a control series irrigated with room temperature solutions. The use of cold solutions was found to reduce the bleeding associated with these operations to simplify the surgical procedure and to result in less surgical complications. Body core temperature was found to be affected very little by the use of cold solutions even in prolonged irrigations in debilitated patients. There was no evidence of physiological derangements attributable to the use of cold solutions. The rectal temperature was seen to be affected markedly by bladder irrigation with cold solution and an explanation for this was offered.

One of the most significant observations in our study was that a sharp fall in rectal temperature of more than 7 or 8 degrees centigrade was found to provide an early warning of excessive direct venous infusion by chilled

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solutions or other surgical complications. This did not occur in the control series. Because of this finding we now recommend that rectal temperatures alone be monitored during this procedure.

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BACTERIA AND SHOCK Bacteria and their products may contribute to the pathogenesis of irreversible shock. Severe but reversible hemorrhagic shock was produced in rabbits. These animals retained normal susceptibility to colon bacillus endotoxin and to clostridia toxin. When the animals were subjected to both toxins, after a similar hemorrhage, their susceptibility was increased several hundredfold. (*Greisman, S.: On Collapse of Bacterial Endotoxin Resistance Following Hemorrhage, J. Exper. Med.* 112: 257 (Aug.) 1960.)

FROZEN RED CELLS Long term storage of human red blood cells is desirable for both civilian and military use. A technique has been developed for accomplishing this, using the Cohn-ADL fractionator and frozen cells. After storage for over three years, the red blood cells have been used with completely satisfactory results and with no side-effects. The advantages of the method are: simplicity, reproducibility, elimination of waste due to

outdating, versatility of use, the feasibility of true "blood banking," whereby an individual can store his own blood for later use, and stock-piling for use in disasters. (*Tullis, J., and others: Clinical Use of Frozen Red Cells, A.M.A. Arch. Surg.* 81: 151 (July) 1960.)

SMALL MOLECULE DEXTRAN Blood is a suspension, the stability of which is dependent on the composition of the plasma, the hematocrit, and the speed of flow. Large and asymmetric molecules cause increased viscosity and reduce the stability of the suspension. This is followed by cell aggregation and reduction of the number of circulating blood cells, hypoxia, and delayed wound healing. A dextran fraction of low molecular weight (about 50,000) was found to be useful in conditions associated with capillary stagnation and shock, such as trauma, burns, and peritonitis. (*Gelin, L., and Zederfeldt, B.: Low Molecular Weight Dextran—Rheologic Agent Counteracting Capillary Stagnation, Acta Chir. Scandinav.* 119: 168 (June) 1960.)