stretched out immobile and rigid; later it passed through a period of inco-ordination on movement. Next day it was less rigid, but was not well and died the same night, about thirty-six hours after the injection.

In one of my experiments a rabbit, weight 1.38 kilos, received 20 c.cm. of a 5 per cent. solution of beta-eucaine borate (=720 mg. per kilo). This dose is approximately ten times the minimal lethal dose of cocaine hydrochloride. The animal had convulsions lasting twenty minutes, but recovered.

Beta-eucaine borate is not more irritant for rabbits than cocaine hydrochloride, and it is less irritant than beta-eucaine lactate. Thus, in a rabbit 0.5 c.cm. of a 10 per cent. solution of beta-eucaine borate injected subcutaneously caused slight thickening and hyperaemia lasting three days; the same dose of beta-eucaine lactate in equal concentration caused much thickening and ecchymosis lasting seven days, and this was followed by sloughing, as in Le Brocq's experiment.² This irritation may not be of practical importance when the greater dilution of the solutions as compared with cocaine hydrochloride is taken into account. Beta-eucaine borate is a vaso-dilator, and, in the cat, a 2 per cent. solution causes marked congestion of the nasal mucous membrane.

Conclusions.

1. Beta-eucaine borate has three times the surface anaesthetic action on the rabbit's cornea, and one-tenth the experimental toxicity, as compared with cocaine hydrochloride.

2. It is mildly irritant, causes some congestion, especially in the nose, and, in very large doses, excites the central nervous system.

This research was carried out during my tenure of the Ernest Hart Memorial Scholarship of the British Medical Association. I desire to express my thanks to the Medical Research Council for the special grant it made for the expenses.

REFERENCES.

- ¹ Copeland and Notton: *BRITISH MEDICAL JOURNAL*, September 26th, 1925, p. 547. ² Le Brocq: *Ibid.*, 1909, i, p. 783.

THE CLINICAL VALUE OF BOROCAINE IN OPHTHALMOLOGY.

BY

T. HARRISON BUTLER AND R. U. GILLAN.

RECENTLY there appeared in the *BRITISH MEDICAL JOURNAL* (1925, ii, p. 547) a most interesting account of borocaine, showing that it should be an efficient substitute for cocaine in operations demanding surface anaesthesia. I at once procured a supply for trial. The tests were made at the Birmingham Eye Hospital, at the Coventry and Warwickshire Hospital, and at the Warneford Hospital, Leamington. Borocaine was used for the removal of foreign bodies from the eye and for tonometry.

At the Birmingham Eye Hospital, where anything up to eighty cases of foreign body in the eye are treated daily, I asked the out-patient sister to try borocaine in 2 per cent. solution. She reported to me that were she to go on with it it would be impossible to finish the cases, for the drug took such a long time to act, and that even then it was ineffective.

At the Warneford Hospital borocaine was investigated by my house-surgeon, Mr. Mackenzie, and by the out-patient sister. The report was that even in 4 per cent. solution borocaine was ineffective. I myself tried it upon two cases for the purpose of finding the intraocular tension with the Schiötz tonometer. I found that after twenty minutes' anaesthesia the cornea was still sensitive, and that repeated instillation of borocaine was ineffective. I put in a drop of holocaine, and at once was able to use the instrument. Another case gave three minutes for the induction with borocaine, three seconds for cocaine.

At the Coventry Hospital I suggested to my house-surgeon, Mr. R. U. Gillan, that he should carry out a research upon the value of borocaine. His results were the following.

AN INQUIRY INTO THE VALUE OF BOROCAINE AS A SURFACE ANAESTHETIC FOR THE EYE: A COMPARISON WITH COCAINE.

Observations were made on over 200 eyes, attention being given to the following considerations:

1. The practical value of borocaine in the removal of foreign bodies lodged on the surface or in the superficial layers of the cornea.
2. The comparative value of cocaine for the same purpose.
3. The extent and duration of the anaesthesia induced by borocaine and cocaine respectively.
4. The after-effects of borocaine upon the condition of the eye compared with the after-effects of cocaine.
5. The effect of borocaine and cocaine upon the state of the pupil and upon the tension of the eye.

Under the first heading 44 cases of foreign body in the cornea were tested with 2 per cent. solution of borocaine with glucose and adrenaline in normal saline. The results were very variable.

In 2 cases repeated instillations failed to abolish corneal sensation and cocaine had to be used. In 2 cases a second instillation had to be made to allow painless removal. In 3 cases spasm of the lids made removal difficult. In 5 cases the patient felt the operation but did not complain. In 3 cases the patient complained of pain during removal. Six cases were treated with ease, and the removal was in all respects satisfactory. The remainder were treated without difficulty, but there was a tendency to spasm. A foreign body embedded in the conjunctiva was removed with the aid of scissors without pain.

In the next series of 36 cases 4 per cent. borocaine was used in the hope that anaesthesia might be more consistent and complete, but the results were still variable. The outstanding feature was the spasm induced by the drug before the onset of anaesthesia. This was present in all cases. The anaesthesia was generally complete. The average time occupied by the operation was 116 seconds.

In 21 cases the removal was easy and unattended by any unpleasant symptoms. In 13 the removal was made difficult by palpebral spasm. In 4 there was actual sensation of pain.

The results obtained with 2 per cent. cocaine in normal saline with glucose were steadily uniform. There was no sensation of pain and no spasm of the lids. The average time occupied was fifty-eight seconds (20 cases).

Under the third heading 42 cases were treated with 2 per cent. borocaine. The average time of induction was found to be from ten to twenty seconds, usually fifteen seconds. The anaesthesia was complete in most cases to light touch, pressure, and to the pain sense.

In 7 cases anaesthesia was complete to light touch, but pressure was felt and the pain sense was not abolished. In 2 cases light and deep touch was not felt, but pain was not abolished. In 4 cases all forms of corneal sensation were still present.

Eleven cases were treated with 4 per cent. solution of borocaine. The induction period was usually fifteen seconds. Before this time had elapsed the corneal surface could not be touched because of the initial spasm. One patient retained the feeling of pressure and the pain sense.

The induction period for 2 per cent. cocaine was found to be ten to fifteen seconds for light touch and from fifteen to thirty seconds for deep touch and pain. Anaesthesia was complete in all cases.

Duration of the Anaesthesia.—This was tested by the corneal reflex and by the sensations of the patient. Under 2 per cent. borocaine the corneal sensation returned in a period of from 30 to 210 seconds, the average being 120 seconds. The corneal reflex returned in from 75 to 300 seconds, the average being 180 seconds. Under 4 per cent. borocaine corneal sensation returned in from 150 to 500 seconds, the average being 370 seconds. The corneal reflex was in most cases not present in ten minutes, the earliest return being 240 seconds. Under 2 per cent. cocaine the period of anaesthesia lasted from 90 to 300 seconds, the average being 200 seconds. The reflex was in most cases not present in five minutes, the lowest period

being 180 seconds. Conjunctival anaesthesia under borocaine usually lasted well over five minutes with the 2 per cent. solution, and over ten minutes with the 4 per cent. solution. With cocaine anaesthesia the conjunctiva was always insensitive for at least five minutes.

After-effects.—To test the after-effects the anaesthesia was induced with 5 per cent. cocaine and with 4 per cent. borocaine, and the eye was inspected the next day. Borocaine was used in 31 cases and 16 returned. Cocaine was employed in 31 cases and 18 returned. The accompanying tables record the results, and so far as they go point to cocaine, even in 5 per cent. solution, as being less harmful to the corneal epithelium than borocaine. Removal of a foreign body appears to be more likely to be complete in the case of cocaine than in that of borocaine. The effect upon the tension is shown in Table III (some of the cases tested had glaucoma). It would appear that the effect of the two drugs is much the same, but borocaine appeared to cause a rise of tension in a greater number of cases than cocaine.

TABLE I.—5 per cent. Cocaine.

Subjective Condition.	Condition of Conjunctival Vessels.	Condition at Site of Removal.
Irritable	Injected	Irregular peeling of surface epithelium.
Irritable	Marked injection	Circumscribed ulceration.
Irritable	Marked injection	Irregular peeling of superficial epithelium.
Comfortable	No injection	Area circumscribed; no staining with fluorescein.
Comfortable	No injection	Area circumscribed; no staining.
Painful	Injection	Traces of foreign material; slight staining.
Comfortable	No injection	Area circumscribed; no staining.
Comfortable	Slight injection	No spread; no staining.
Comfortable	Slight injection	Slight staining; some ulceration.
Comfortable	Slight injection	Area circumscribed; no loss of substance.
Comfortable	No injection	Area circumscribed; no loss of substance.
Comfortable	Slight injection	No spread; no staining.
Comfortable	Slight injection	No loss of tissue; no staining.
Comfortable	Slight injection	Staining at site, but no spread.
Irritable	Injection	Circumscribed ulceration.
Irritable	Intense injection	Loss of substance; some spread.
Painful	Much injection	Circumscribed ulceration.
Comfortable	No injection	No loss of substance.

TABLE II.—4 per cent. Borocaine.

Subjective Condition.	Condition of Conjunctival Vessels.	Condition at Site of Removal.
Comfortable	Slight injection	No loss of substance; no staining.
Comfortable	" "	Staining; tendency to spread.
Irritable	" "	No loss of substance; no staining.
Irritable	" "	No loss of substance; no staining.
Irritable	Injection	Circumscribed loss; staining.
" Aching "	" "	Staining; loss of substance; trace of foreign matter.
Comfortable	" "	No loss; no staining.
" Aching "	" "	Circumscribed loss of substance; staining.
Comfortable	" "	Loss of substance; some spread; staining.
" Aching "	" "	Trace of foreign matter; staining.
Irritable	" "	Irregular loss of substance; staining.
Irritable	Injection, palpebral oedema	No loss of substance; no staining.
Painful	Injection	Widespread loss; staining.
Irritable	" "	No staining; no loss.
Irritable	" "	No loss; no staining.
Comfortable	" "	Circumscribed ulceration.

TABLE III.—Effect upon Tension.

No.	Age.	Method.	Tension.	Tension after 15 minutes.	Mydriasis.
1	19	Borocaine 4%	Schiötz units 19	Schiötz units 19	No.
2	42	" 4%	19	22	No.
3	62	" 4%	26	27.5	Yes.
4	68	" 2%	22	22	Yes.
5	42	" 2%	20	20	No.
6	51	" 2%	26	18	No.
7	74	" 4%	16	16	?
8	40	" 2%	22.5	22.5	Yes.
9	18	" 2%	65	67	Yes.
10	70	" 4%	16	22	No.
11	66	" 2%	24	26	Yes.
12	52	" 2%	12	10	?
13	21	" 2%	16	12	Yes.
14	60	" 2%	56	54	Yes.
15	56	" 2%	10	12	?
16	77	Cocaine 2%	10	12	Yes. +
17	75	" 2%	22	20	No.
18	39	" 2%	19	17	Yes.
19	39	" 2%	19	16.5	Yes.
20	74	" 2%	24	20	Yes.
21	63	" 2%	22.5	20	Yes.
22	32	" 2%	22.5	19	Yes.
23	52	" 2%	32	27	No.
24	59	" 2%	51	51	No.
25	56	" 2%	17	20	No.
26	52	" 2%	12.5	13.5	Yes.
27	26	" 2%	22.5	18	No.
28	26	" 2%	19	19	No.
29	63	" 2%	20.5	24	No.
30	32	" 2%	16	14	No.

The conclusion of the two authors is that borocaine is greatly inferior to cocaine as regards its surface anaesthetic effect. Cocaine is perfectly reliable, whereas the effect of borocaine is variable.

The cost of borocaine makes it an impossible drug for hospital use, the more so as it appears to have no advantages.

THE CLINICAL USE OF BOROCAINE BORATE AND BETA-EUCAINE BORATE FOR URETHRAL ANAESTHESIA.

BY

RALPH COYTE, M.B.LOND., F.R.C.S.ENG.,
ASSISTANT SURGEON TO ALL SAINTS' HOSPITAL AND THE QUEEN'S
HOSPITAL FOR CHILDREN,

BOROCAINE borate and beta-eucaine borate have both been used at All Saints' Hospital for Genito-Urinary Diseases to provide urethral anaesthesia before the passage of various instruments. In the cases here remarked two injections of half an ounce were given at an interval of five minutes. After waiting for three minutes the selected instrument was passed.

BOROCAINE BORATE.

In two cases 0.5 per cent. solution was used; in both of these 0.5 solution of cocaine hydrochloride was used as a local anaesthetic at previous instrumentation. The first case was for the passage of a cystoscope, and the second for a No. 20 French gum-elastic bougie. These two patients