Y. KEWENTER, HÄLSINGBORG:

AVERTIN AND EVIPAN SODIUM ANESTHESIA IN ORTHOPEDICS

In the last few years a whole literature has grown up around those two new anesthetics, avertin and evipan-sodium. Also in the Scandinavian professional literature a great many articles have been published, dealing with their chemistry and use. I shall therefore not here discuss their chemical and pharmacological properties, nor enter into any long description of the method of their administration, but will only briefly set forth the views and conclusions to which we have come, at the Cripples' Hospital in Helsingborg, concerning their use in orthopedic surgery. Though our material is by no means large, I hope that an account of our experiences may be of some interest.

With *evipan sodium, given intravenously,* we have operated on nearly 100 cases, 60 of which were of a more or less orthopedic character; with *avertin, administered per rectum,* on about 50. I take first the cases in which evipan was used, because that was the method, of the two, which we first employed.

The patients were, without exception, in good health, except for the orthopedic affection on account of which they had been admitted. There have thus been none of those conditions present which have so far been mentioned as contra-indications to the use of evipan, such as hepatic diseases, peritonitis, senile or cachectic symptoms, circulatory or respiratory disorders. The same applies to the avertin patients.

The ages of these 60 patients were as follows:

Age:	2—5	5—10	10—15	15—20	20—30	30—40	40—50	
Number:	3	13	16	13	11	3	1	= 60

The youngest was three, the oldest fifty years old. Fifty of the sixty—or 83.33 per cent.—were in the ages of from 3 to 30 years; that is to say, in their best age.

As basis for the dosage, we have used the table worked out, by *Specht,* at *Anschütz*'s clinic in Kiel (see Table I); but, like most authors, we have come to the conclusion that evipan must be given very individually; one patient tolerating somewhat more, another somewhat less, than the tabulated dose. The extent to which this is the case will be seen from the manner in which the patient reacts during the injection. I also believe it to be highly important that the injection be done very slowly, especially that of the first and *the last* cubic centimetre. In a couple of cases, the patient got very restless toward the end of the injection; though, to my belief, there was no question of over-dosage. I think I have since avoided this by giving the last part of the dose very slowly, taking 20 to 30 seconds to inject each cubic centimetre. The smallest dose given has been 2 c.cm., the largest 14 c.cm.; the latter divided: 8 + 2 + 4 c.cm. Such repeated dosage was given in 7 cases. I must say that, in my opinion, this reiterated administration is not only a trouble,—unless one has a large medical staff at one's disposal, but there is something that speaks against giving the patient more than the dose first calculated; then better resort to inhalation anesthesia right away.

According to the manner in which evipan was used either alone or in conjunction with ethyl chloride or ether, the 60 cases distribute themselves as follows:

	Number of cases
evipan alone	35
» , reiterated doses	7
» + ethyl chloride	4
» + less than 15 grs. ether	3
» + » » 50 » »	5
» + » » 100 » »	2
+ over 100 grs. ether	4
	60

We thus see that in 35 cases no other anesthetic had to be resorted to. If, to these 35, we add the 3 cases in which less than

15 grs. of ether were given, we get 38 cases, or 66.66 per cent., in which evipan alone produced complete, or almost complete, anesthesia. In the remaining one-third of the cases, the evipan injection had to be supplemented to a greater or lesser extent with ethyl chloride or ether. In 4 cases, over 100 grs. of ether were given; in one of these as much as 190 grs.

It will be asked whether evipan has proved useful as an anesthetic for operation and surgical intervention in orthopedic cases; and, if so, if this usefulness is greater in regard to certain categories of cases than to others. In order better to answer those questions, I have made a group-tabulation of the various cases in which it has been used (Table II). As this table shows, operations on the foot have been done in 11 cases, 4 of which were carried through under evipan alone, the 7 others either under repeated administration of evipan or supplemented by inhalation anesthesia with ethyl chloride or ether. In 2 knee-operations, relatively large doses of ether were given in addition to the 10 c.cm. evipan injected. Of 16 osteotomies, 11 were done with the use of evipan alone; and in 3 others only small doses of ether, not more than 15 grs., had to be given as supplement. Of the other operations—arthrodesis of the shoulder-joint, Albee's bridge operation, torticollis, etc.—only 1 for torticollis could be carried through without supplementary anesthetic; for all the others more or less considerable doses of inhalation anesthetics had to be used. Of 5 subcutaneous myotenotomies, 1 was done with only 5 c.cm. evipan, while the others required either repeated doses or evipan or to be supplemented with some ether. The last group comprises 20 bloodless operations—resetting of fractures, epiphyseolyses, correction of contractures in various joints, correction of osteotomies, etc.; all of which were carried out with the use of nothing but the one dose of evipan administered. It thus seems strongly evident that *osteotomies and bloodless corrections are the operations for which evipan can be used to the greatest advantage.*

The operations lasted from a little less than 10 minutes to something over 1 hour; the average was from 15 to 20 minutes. The length of time that the patient was asleep was as follows (the time given only for 41 cases):

Minutes:	5—15	15—30	30—45	45—60	60—90	90—120	120—150
No. of cases:	4	13	11	8	1	3	1

The average, in our cases, was about 30 minutes. The patients who slept for over 1 hour had all been given ether in rather considerable doses.

Blood pressure and pulse rate were controlled before, during, and after the operation, in 50 per cent. of the cases. The fall in blood pressure was from 5 (minimum) to 45 (maximum) mm.; average, 20 mm. The pulse rate usually rose, though not to any marked extent. The pupillary reflexes were always found present.

The patients fell asleep quietly and without experiencing any unpleasant sensations, except in the cases which I have already mentioned, where signs of excitement were shown. In 2 cases, the awakening was followed by a state of restlessness; but in one of those cases the patient had been given ethyl chloride in addition to the evipan, and it is therefore difficult to say to which of the two this should be ascribed. Perhaps to the combination of the two? Eight patients felt sick and vomited; 2 of these had had evipan alone, 2 evipan + ethyl chloride, and 4 evipan + ether (resp. 45, 120, 150 and 190 grs.). In no case were there any other complications following the use of evipan.

If I am asked about the attitude of the patients toward this form of anesthesia, I can only say that they are very glad and thankful for it. With a number of the children in our Educational Home, who had previously undergone operations for which they had been given ether, it has, since we began with evipan, been the standing, anxious pleading: »Oh, doctor, can't I just get a little »prick«?—Some time ago we did a supracondylar osteotomy on a man, about thirty years old, who had a couple of times before been operated on, under ether narcosis, for some affection not of orthopedic character. In contrast to what had been the case on those previous occasions, he, this time, neither felt sick nor vomited after waking; and when he immediately was given something to drink, and shortly after was allowed some coffee and bread, his surprise and thankfulness

were almost boundless. The prick of the injection, when a fine needle is used, causes practically no pain, or is at least so slight that very few children react to it; and consciousness disappears so quickly—in the course of a few minutes—that, psychically, this method of anesthetisation must be regarded as very easy on the patient. To this must be added the generally quiet wakening, after which the patient is given something to drink or eat, whereupon he soon drops off to sleep again.

Avertin anesthesia per rectum we have used in 48 orthopedic cases. The ages of these patients were as follows:

Age:	0—2	2—5	5—10	10—15	15—20	20—30	30—40	40—50	50—60	60—7
Number:	7	4	9	6	2	7	4	6	2	1

As compared with the evipan cases, the cases in which avertin was used were thus more evenly distributed over the different age-groups. The youngest patient was 9 months old, the oldest 63.

As basis for calculating the dosage, we have used *Domanig*'s table, the details of which will be found on Table III. The largest dose given was 0.125 gr. per kilogram body-weight, the smallest 0.1 gr. per kg. b.—w. The former was the dose generally used for patients under the age of 16. Patients under the age of 16 to 18 have not been given any narcotic or other pre-medication previous to the injection of the avertin enema. Patients over that age we have, as a rule, given morphia, 1—1.5 centigr., and ephetonin, 1 c.cm., the latter to counteract the fall in blood pressure.

According to the manner in which avertin was used either alone or in conjunction with various amounts of ether, the 48 cases distribute themselves as follows:

	Number of cases
avertin alone	11
» + less than 15 grs. ether	15
» + » » 50 » »	21
» + » » 100 » »	1
	48

In 26 cases, the anesthesia was thus complete, or almost complete; in 21 cases, up to 50 grs. of ether were given; in 1 case 55 grs. We can consequently consider the anesthesia to have been satisfactory in 100 per cent. If we make a group-tabulation of these cases, similar to the one for the evipan cases, we see (Table IV) that, of the total forty-eight, 24 were operations on the foot, 2 of which were bloodless operations. Of these twenty-four, 11 were carried through under avertin alone, 6 under avertin supplemented with at most, 15 grs. of ether; while, in the remaining 11, from 25 to 50 grs. of ether were given as supplement to the avertin. Of 7 knee-operations, 2 were done without additional inhalation anesthesia, 1 with 15 grs. supplementary ether, the other 4 with from 25 to 50 grs. Of 5 osteotomy cases, 2 had avertin alone, 1 avertin + only 10 grs. of ether, 2 avertin + respectively 20 and 40 grs. of ether. In the other operations—antecrural pseudarthrosis, arthrodesis of the shoulder-joint, Sprengel's deformity, etc.—from 15 to 55 grs. of ether were given. As a group by themselves stand 7 cases of congenital dislocation of the hip. It will be noticed that in none of these cases could the reposition be done under avertin alone, but that, in them all, inhalation anesthesia had to be used in addition; in 5 cases only 15 grs., in the remaining 2 respectively 20 and 45 grs. of ether. Precisely this operation shows, as clearly as one could wish, the drawback attaching to the avertin; namely, that the anesthesia produced is not so deep that it allows the musculature to become sufficiently relaxed to make it possible to perform, for instance, the reposition of a dislocated hip.

The operations lasted from 10 to 90 minutes; in average 30 minutes. The length of time before the patients regained consciousness after the operation was as follows:

Time:	0—30 min.	30 min.—1 hr.	1—2 hrs.	2—3 hrs.	3—4 hrs.	4—5 hrs.	5—6 hrs.
Patients:	2	14	22	7	1	1	1

The shortest time any of them staid asleep was 5 minutes, the longest 5 hours and 10 minutes. In this last case, avertin alone had been employed.

Blood pressure and pulse rate were controlled in all the cases. The fall in blood pressure varied from 5 to 45 mm.; average, 20 mm. The fact that, at the Cripples' Hospital, Esmarch's bandage is used in nearly all cases of leg-operations, proved of great advantage in connexion with the avertin anesthesia; inasmuch as, when the bandage had been applied, the blood pressure rose again, 10, 20 to 30 mm. The variations in the pulse rate were in most cases slight. In one case, where the patient's pulse became rather bad during the operation, coramine was given as a matter of precaution, whereupon the pulse immediately became regular and full again. A large dose of coramine (5 c.cm.), given intravenously, has been recommended as a specially good means of getting the patient back to consciousness from an avertin narcosis. I have therefore tried this once, in order to see the effect. The result was that the patient did not wake completely, but while the coramine was injected he began to stir, and rubbed his eyes. The effect was thus noticeable, though not so strong as some authors have stated it to be.

All the patients fell asleep perfectly quietly and naturally after the enema. The youngest, 9 months old, went to sleep in 4 minutes, yawning and rubbing his eyes. Most of them were asleep in 10 minutes, some sooner (2 to 3 minutes), others again not until after 20 or 30 minutes. The operation was begun when the patient had been asleep for 15 to 25 minutes, as that is the time when the sleep is thought to be deepest.

The return to consciousness was followed by vomiting only in 3 cases, in all of which ether had been administered in addition to the avertin. None of the patients showed signs of restlessness after waking. Intestinal disturbances set in in 3 cases; in one of them already during the first 24 hours, in the two others during the second 24-hour period; in one of the latter cases the disturbance was rather troublesome. Of other complications there were none in any of the cases.

The opinion of the patients with regard to this form of anesthesia has, almost without exception, been enthusiastic. »It was lovely«, and »splendid«, were expressions we heard in not a few cases. One man, 46 years old, who suffered from very troublesome

club-feet, came to the institution and wished to have a fresh operation performed on one of his feet. He had already been operated on thrice before; among other things, a tarsectomy had been done on his other foot. The only thing he now hesitated about, and was afraid of, was the anesthetic; as, on the former occasions, when he had been given ether, he had had difficulty in getting to sleep, and, after the operations, had been severely troubled with vomiting, etc. He was now given morpia, 1.5 centigr., ephetonin, 1 c.cm., and avertin, 5.8 c.cm., and was quietly asleep in 6 minutes. The operation—a tarsectomy—took 25 minutes, whereafter he slept for another hour and a half. After waking, he had none of the troubles experienced on the former occasions, and explained, with the most radiant countenance: »I didn't feel anything; I dont remember anything at all«. One hour after waking, he lay happy in bed, drinking coffee and eating sandwiches.

None of the patients remember anything from the time the avertin enema is given till they wake up after the operation. The avertin anesthesia is perhaps even easier, psychically, on the patient, than evipan. I have not seen a single one of the children resist, cry out or vomit; which is, of course, because the enema did not hurt, and because they didn't know for what purpose it was given, before they were already asleep,—or rather, before they woke up and the operation was already over. I even seem to have noticed that the patients needed less of narcotics than after the evipan anesthesia, at least during the first twelve hours; partly because they, in many cases, stay asleep rather long in direct sequel to the narcosis; partly also because they, after recovering from the latter—and often then getting something to eat and drink—usually drop off again into a quiet, natural sleep.—

From this account of our experiences, it will probably be clear what impression I have gained of the two anesthetics and their uses. But to sum the whole matter up briefly, I would say that, in my considered opinion, intravenous evipan-anesthesia and avertin-anesthesia *per rectum* both offer so great advantages that neither of them should be allowed to be absolutely discarded

in favour of the other. Both are easy to administer, and both are easy on the patients, psychically; not only in the way they produce unconsciousness, but also in the way recovery from the unconsciousness takes place. In the field of orthopedics, evipan is of greatest value for short operations and corrections; avertin for longer operations, as complete anesthetic or as basal narcotic. The usefulness of avertin is further enhanced by the fact that it can be used even for infants and young children.

TABLE I

DOSAGE TABLE FOR EVIPAN SODIUM (SPECHT)

Ages	10—15	15—25	25—40	40—55	55—65	65—75	over 75	
Males, strong ...	0.16	0.15	0.14	0.13	0.12	0.11	0.10	c.cm.
feeble ...	0.15	0.14	0.13	0.12	0.11	0.10	0.09	
Females, strong	0.15	0.14	0.13	0.12	0.11	0.10	0.09	
feeble	0.14	0.13	0.12	0.11	0.10	0.09	0.08	

For fat, anemic, septicemic, cachectic and other severely sick patients, the dose should be reduced by 30 to 50 per cent.; likewise for short operations, and for operations on out-patients. For thin, but vigorous, male patients from 15 to 25 years old, the dose should be increased by 10 to 20 per cent. Maximum single dose, 10 c.cm. Only in exceptional cases may this be exceeded by up to 20 per cent.; in all other cases it is better at an early stage to give an inhalation anesthetic as supplement. The definitive dose to be administered must be determined in the course of the injection. Time for injecting the dose, 2 to 3 minutes.

TABLE II

OPERATIONS PERFORMED UNDER EVIPAN ANESTHESIA

OPERATION	Age	Evipan c.cm.	Supplement
On the foot (11; 4 of which with evipan alone):			
Arthrodesis (4 joints)	13	7	ethyl chloride
	20	8+2	
	11	6	
	11	7	ether, 45 grs.

TABLE II (continued).

OPERATION	Age	Evipan c.cm.	Supplement
Tarsectomy	12	7	
	16	10	ether, 105 grs.
	16	7.5	» , 25 »
Op. on toes (hallux valgus, etc.)	20	8+4	
	24	9	ether, 100 grs.
Achillectomy	9	5	
	11	5.5	
On the knee (2; none of which with evipan alone):			
Luxation of menisci	18	10	ether, 150 grs.
	28	10	» , 120 »
Osteotomies (16; 9 of which with evipan alone):			
Antecrural	8	4	
	6	3.5	
	3	2	ether, 5 grs.
	13	5	
	4	3	
supracondylar, on femur	23	8+2+4	
	10	4.5	ether, 15 grs.
	29	10+5	
	12	7	
	22	7.5	
	6	5	
subtrochanteric, on femur	11	7	
	16	10	
	13	5	
	31	8	ether, 50 grs.
	26	7	» , 5 »
Bloodless operations (20; all with evipan alone)	10	4.5	
	10	3.5	
	16	6	
	14	6	
	17	7.5	
	16	8	
	39	7	
	5	2.5	
	12	4.5	

TABLE II (continued).

OPERATION	Age	Evipan c.m.	Supplement
	20	6.5	
	10	3.5	
	18	7	
	50	6.5	
	5	2.5	
	11	5	
	20	6	
	8	5	
	13	4	
	10	4	
	18	7	
Myotenotomies, subcutaneous (5; 1 of which with evipan alone) ...	25	10+4	
	10	4.5	ether, 30 grs.
	25	10+5	
	12	5	
	13	6+4	
Other operations (6; 1 of which with evipan alone):			
Arthrodesis of shoulder-joint ...	19	8	ether, 40 grs.
Albee's operation	18	10	» , 100 »
Torticollis	11	5.5	ethyl chloride
	8	6	
Luxation of acromioclavicular joint	23	8	ether, 190 grs.
Amputation of leg	10	6.5	ethyl chloride

TABLE III

TABLE FOR CALCULATION OF AVERTIN DOSAGE (DOMANIG, MODIFIED)

Sex	Ages	Power of resistance. General condition	Sensitivity to anesthetics	Vigorous children
Children				
(both sexes) 4	1—15 ... 4	robust 3	none 4	1—2
adult male 3	15—35 ... 3	vigorous . 2	slight 3	—
» female 2	35—60 ... 2	medium .. 1	normal 2	—
elderly m. & f. 1	60—80 ... 1	poor 0	hyper- 1	—

Classification index	3	4	5	6	7	8	9
Dose per kg. body weight:	0.08	0.085	0.09	0.095	0.1	0.105	0.11

10	11	12	13	14	15	16	17	
0.115	0.12	0.125	0.13	0.135	0.14	0.145	0.15	grs.

Examples:

Elderly woman	1	Young man, vigorous	3
Age, 73	1	Age, 25	3
Gen. cond., poor	0	General condition, good	3
Hypersensitive	1	Sensitivity, slight	3
	3		12

Index figure: 3 = 0.08 gr. per kg.; body weight, 50 kg. Dose, consequently: *avertin, 4 grs.*

Index figure: 12 = 0.125 gr. per kg.; body weight, 70 kg. Dose, consequently: *avertin, 8.75 grs.*

TABLE IV

OPERATIONS PERFORMED UNDER AVERTIN ANESTHESIA

OPERATION	Age	Supplement. ether, grs.
On the foot (24; 7 of which with avertin alone):		
Arthrodesis (4 joints)	22	40
	14	*15*
	10	35
	22	35
	49	30
	7	
	38	
	15	
	8	30
Tarsectomy	7	
	46	
Extirpation of talus	23	40
Hallux valgus	55	*15*
	43	50
Metatarsal joint	14	25
	4	25
Achillotomy	2	5
	13	*15*
	5	*10*
	8	30

TABLE IV (continued).

OPERATION	Age	Supplement. ether, grs.
Musculoplastics	1	5
	15	50
Bloodless correction	2	
	1	
On the knee (7; 2 of which with avertin alone):		
Resection of knee-joint	43	40
Suspected tuberculosis	28	
	63	*15*
	14	30
Osteochondritis	41	30
Meniscopy (1 ganglionitis, 1 rupture)	20	25
	53	
Osteotomies (5; 2 of which with avertin alone):		
Rotation of leg	4	
supracondylar, on femur	28	20
subtrochanteric	31	*10*
	33	
	33	40
Congenital dislocation of hip (7)	2½	*15*
	1½	*15*
	7	20
	7	*15*
	2	*15*
	6	45
	1½	*15*
Other operations (5):		
Arthrodesis of shoulder-joint	18	55
Pseudarthrosis of the leg	3	40
Luxation of acromioclavicular joint	23	40
Sprengel's deformity	9	*15*
Amputation of femur	49	50

DISCUSSION:

Kj. Bergman, Malmö:

It is undeniable that evipan sodium possesses a great many advantages as an anesthetic. The patients fall asleep after only a few minutes, without any previous excitement or restlessness,

sleep quietly during the whole of the narcosis, and the recovery is free from after-effects in the form of vomiting or other feelings of sickness. All this must, of course, impress anyone very favorably who has had occasion to witness an anesthesia of this kind. The method has one drawback, however,—and that a very serious one,—namely, the dangerousness of the drug. I have not much to add to the remarks already made by Dr. *Hansson;* I will only supplement them by quoting from the statistics presented by *Anschütz* at the German Congress of Surgery in 1933. *Anschütz* had collected from the literature 6.400 cases of evipan sodium anesthesia. Of those, no less than 4 had died under the anesthesia itself. One notices especially the case of a strong, healthy woman, twenty-four years old, on whom an operation was to be done for removal of a fetus, and who died a few minutes after the injection of only 4.5 c.cm. of evipan. A case like that gives one something to think about, and makes one anxious to go back to methods less dangerous.

G. Pallin, Kristianstad:

I only wish to register my cordial agreement with the opinion expressed by Dr. *Johansson* concerning the great value of spinal anesthesia, by Jones's method, for operations on the lower extremities; not least on account of the complete relaxation it produces of the muscles. I would call attention to the importance of following Jones's directions very closely, especially as regards the divided dosage; something which I think is by no means paid sufficient attention to in all places.