Report

OF

A SUCCESSFUL CASE OF EMBOLECTOMY.

WITH A REVIEW OF THE LITERATURE.

BY

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Cases of embolism in which the plugged artery has been opened and the clot removed with complete success are sufficiently rare to make records of single cases worth the making. The clarification of our views on this subject has largely come about through Einar Key of Stockholm, whose masterly paper (1922) has done much to advance the surgical treatment of embolism. It is interesting to note that, whereas prior to 1922 only thirteen successes could be claimed out of forty-five cases, no fewer than fifteen successes have been obtained in twenty-eight cases published since that date. The result of the local teaching of Key is reflected in the literature of "embolectomy," which has been until now almost a Scandinavian operation. Pioneer work was done in England by Handley, Moynihan, Brockman, and Gordon-Watson, though their cases were less fortunate in result than that now chronicled.

J. E., male, aged 42, a patient of Dr. Gray of Tyldesley, was admitted to the Salford Royal Hospital under my care for the radical cure of an umbilical hernia. The hernia was small and contained a little omentum only. The patient was well built, rather obese, but was in excellent general health. He had had no serious illnesses. The heart was normal, the pulse 80, and the urine free from abnormal constituents.

On April 23rd, 1925, radical cure of the hernia was performed by the resident surgical officer, Mr. R. L. Galloway. A transverse elliptical incision $3\frac{1}{2}$ inches long was made, the neck of the small hernia defined, the sac opened, a lobule of omentum which was lightly adherent was pulled down and ligatured off. The sheath of the rectus was incised and the deficiency repaired. The operation lasted from 3 to 3.15 p.m., and was performed without tearing or bruising. This wound healed by first intention, without any sign of local contusion.

Progress.—A quarter of a grain of morphine tartrate was given at midnight to allay such pain as the patient had. The next morning he looked and felt well. At 5.15 p.m. on this day, twenty-six hours after the conclusion of the operation, whilst being moved in his bed by the nurses, who were straightening the drawsheet, he complained of a tingling sensation of "pins and needles" in the left arm, with increasing numbness. This rapidly developed into an intense pain, with complete paralysis of the arm. I saw him one hour later.

The man was very much disturbed at the sudden paralysis of the limb, and still more so by the pain which accompanied it. The arm was blanched, cold, and pulseless, insensitive to touch, and completely paralysed below the elbow. Feeble movements of flexion and extension were possible at the elbow-joint. On tracing the line of the vessels up the arm pulsation was finally detected high in the axilla, but was not very clear. The man was stout and palpation not easy. Lodgement of an embolus about the termination of the axillary or commencement of the brachial artery was diagnosed, and operation advised. This was eagerly accepted by the patient, who was exceedingly disturbed at his misfortune and in a very agitated state.

At 7.45 p.m., two hours and a half after the embolism occurred, operation was undertaken under novocain and adrenaline infiltration. An incision 4 inches long was made over the axillo-brachial junction and the vessels cut down upon. The incision was placed so as to expose an inch or more of pulsating artery. Further novocain injections had to be made after incising the deep fascia, as the proximity of the great nerve trunks made the exposure of the artery painful at times. The axillary artery was seen to be pulsating freely, but it was not easy to be certain whether the pulsation felt was that of the normal vessel or merely transmitted. As a finger was passed downwards along the vessel a doughy substance was felt in its interior. This distal portion (brachial artery) was seen to be contracted, no larger than the normal radial, so that one passed from normal pulsating vessel, over a resistant portion, to a contracted and apparently empty vessel. The artery was now freely cleared all round. This was difficult owing to the presence of the superior profunda artery, at the origin of which the embolism was situated. Clamps for occluding the

vessel were rapidly improvised by covering the serrated blades of artery forceps with appropriate rubber tubing. With these the vessel was gently held by my assistant, Mr. Galloway, and fulfilled their purpose admirably.

A longitudinal incision about 2 cm. long was made into the vessel and a dark piece of clot immediately protruded. This was gently pulled out with forceps, and proved to be 2 cm. long. The upper clamps were now momentarily released and blood rushed out, but no flow followed the release of the lower clamps. The vessel was therefore "milked" upwards, and a much larger piece of clot, rather whiter and more granular in appearance, was extruded. Blood was now seen to flow gently on release of the lower clamp. The wound in the artery was therefore sewn up with four fine silk stitches on a fine round-bodied needle, the silk having been well soaked in liquid paraffin and the operation field drenched with the same fluid. The suture line was tested by release of the clamps and proved to be water-tight. The clamps were then removed. The patient immediately said, "The pain has gone," and a few seconds later remarked that he could move his fingers, and that the arm was becoming warmer. By the time the deep fascia and skin had been closed full function was restored to the arm, the radial pulse was full and free, the colour pinker than normal, and the grip strong. At first the pulsation in the left radial was not so strong as that in the right, no doubt because of the persistent main trunk constriction to which several writers have referred. In a few minutes at most it became stronger and remained so.

The relief afforded by this simple operation was dramatic in the extreme. From a condition of intense pain immediate respite was obtained. The use of local anaesthesia made it easy to corroborate objective recovery by the testimony of the patient himself, and there can be no doubt that this is the anaesthetic of choice for similar cases.

The arm made a perfect recovery without a suggestion of the most local gangrene, but on the fourth day after embolectomy he had a rigor and complained of intense pain in the right side of the chest. He was examined by my colleague Dr. Langley, who found crepitations at the right base, where a pulmonary embolism had occurred. He found no evidence of cardio-vascular disease or congenital abnormality. Blood appeared in the sputum shortly afterwards, thus confirming the diagnosis. The patient was much troubled by pain and coughing for the next week, but no further embolism occurred. A smooth convalescence followed, and he was discharged from hospital a month later.

I have recently (September 18th) had a further opportunity of examining him, five months after the operation. His doctor informs me that two weeks after the man left hospital he developed a thrombosis of the left femoral vein which gave little trouble, but three weeks after that the right leg became thrombosed, and has continued swollen and painful until now, though he can get about on it. There are some enlarged venous radicles on the lower abdomen, which suggest that the thrombosis has extended perhaps as high as the inferior vena cava. His umbilical hernia and his arm remain in excellent condition. It should be remarked that his legs were frequently examined whilst he was in hospital for signs of thrombosis, but no abnormalities were at any time detected. Why he should have developed a thrombosis later is obscure.

Origin of the Embolus.

The question of the origin of the embolus immediately arises. If he had some undiscovered thrombosis in the veins of the legs or pelvis (and his calves and thighs were never tender or swollen in hospital) the only route by which a portion of clot could have reached the axillary artery would be through a deficiency in the septum of the heart; for, of course, without such a means of short-circuit a thrombus from the systemic or portal venous system must be filtered off by the lungs—the form of embolism with which we are more familiar. As a fact, the patient did have a pulmonary embolism as well, but we shall see that even that did not necessarily arise in a systemic vein. One naturally looks to the operation area as furnishing the clot, and it is a possibility that a "paradoxical embolism" occurred in the arterial tree through a patent foramen ovale. If such a deficiency were not present, then the clot must have come from one of three places—from the pulmonary veins, from the chambers of the heart itself, or from the aorta or subclavian artery. How common is thrombosis in these sites? Fortunately we have some valuable information on that point. P. Bull has analysed 6,140 necropsy records from the Riks-Hospital at Oslo, and finds that the heart has been greatly underestimated as a source of clot for embolism. Thrombosis in the pulmonary veins was only found three

TABLE I.—Embolectomies, 1922-1925.

Case No.	Author.	Site of Embolism.	Sex and Age.	Cause.	Duration of Signs of Arterial block before Operation.	Result.
1	Michaëlsson (1922) ...	Left common femoral	M., 58	Heart disease	28 hours	Amputation; died ten days later.
2	" " ...	Bifurcation of aorta and right common iliac	F., 58	Heart disease	11½ "	Died next day.
3	" " ...	Left common femoral	F., 30	Heart disease	2½ "	Success.
4	Hägg-tröm (1922) ...	Right iliac and femoral	F., 41	—	16 "	Died next day.
5	" " ...	Right femoral and popliteal	F., 52	—	10 "	Subsequent amputation; died six weeks later.
6	" " ...	Left iliac	F., 69	Mitral stenosis	9½ "	Died next day.
7	Sencert and Blum (1922) ...	Right axillary	M., 58	Syphilitic aortitis	About 24 hours	Success.
8	Buerger (1923) ...	Right brachial	M., 57	Chronic endocarditis	6 hours	Died nine days later.
9	" " ...	Right brachial	—	Gangrenous appendicitis	3½ "	Success.
10	Lundberg (1924) ...	Left femoral and popliteal	F., 62	Heart disease; strangulated hernia (operated)	19½ "	Success.
11	Michaëlsson (1924) ...	Left common femoral	F., 78	Aortic disease	2½ "	Success.
12	Perman (1924) ...	Left common iliac	M., 46	Heart disease	3½ "	Success.
13	Lundblad (1924) ...	Bifurcation of aorta	M., 37	Heart disease	Next day	Died.
14	" " ...	Right common iliac	F., 35	Heart disease; parturition two days previously	8 hours	Success.
15	" " ...	Bifurcation of aorta and the external iliac	F., 47	Heart disease	26 "	Died.
16	Olivecrona (1924) ...	Right common femoral	F., 31	Mitral disease	2 "	Success (same patient as No. 3).
17	Gejrot (1924) ... (operated on by Lange)	Right axillary	F., 70	Arterio-sclerosis	1½ "	Died seven days later.
18	Torell (1925) ...	Left superficial femoral	F., 32	Heart disease	23 "	Subsequent low amputation; recovered.
19	" " ...	Right superficial femoral	F., 82	Heart disease	5 "	Success.
20	" " ...	Left superficial and deep femoral	F., 77	Heart disease	4½ "	Died five days later.
21	Dickinson (1925) ...	Right brachial	M., 63	Uncertain	20 "	Subsequent amputation; died thirteen days later.
22	Henney, Snyder, and Hoyer (1925) ...	Left subclavian	F., 62	Cholecystitis	5 "	Success.
23	Turettini and Gruder (1924) ... (operated on by Kummer)	Aortic bifurcation	F., 40	Mitral disease	2 "	Died next day.
24	Aleman (1925) ...	Common femoral	M., 25	Heart disease	4 "	Success.
25	Lundblad (1925) ...	Common iliac artery	F., 44	Heart disease	10 "	Success.
26	Söderlund (1925) ...	Right popliteal	F., 42	Heart disease	12 "	Success.
27	" " ...	Left brachial	F., 46	Heart disease	5½ "	Success.
28	Jefferson ...	Left axillo-brachial	M., 42	After operation for umbilical hernia	2½ "	Success.

times in this large series, and then only in conjunction with clotting in the heart. It was found nine times in the aorta, but only in the presence of severe arterio-sclerosis, and never in any other artery. But thrombi were common in the heart, occurring in 181 cases—67 times on the right, 63 times on the left, and 51 times on both sides. These facts explain the occurrence of embolism in both the systemic and pulmonary circulations, although the lungs are exposed to an additional danger of infarction by the frequency of pelvic and limb thrombosis in the post-operative period. It seems very probable, to put it no higher than that, that in the case just reported both emboli were derived from the heart. It will be noted in the classified list of published cases of embolectomy set out below how common cardiac disease has been as a cause of peripheral arterial block.

Diagnosis of Peripheral Embolism.

There is no need to dwell at any length on the symptoms and signs of peripheral embolism. The sudden onset of intense pain in a limb, with loss of motor power, loss of sensation, pallor, marbling of the skin, subjective and objective coldness of the limb, and absence of pulsation in the chief arteries, form a sufficiently characteristic picture. The more difficult cases are those in which the obturation of the vessel is incomplete at first, becoming absolute later, either by secondary thrombosis or by the embolus slipping lower down into a narrower vessel. The embolus in these cases probably rides the spur at the bifurcation of a large artery or exit of a large branch. One has only to be on the look-out for embolism to make diagnosis certain within the first few hours. Early diagnosis is of paramount importance if operative treatment is to be of real service. It is interesting to notice the effects which Key's teaching

has produced in Sweden, for the practitioners are evidently sending their cases to the surgeon now the moment the relatively easy diagnosis has been made, with gratifying results. If left untreated the majority of peripheral embolisms end in amputation, usually at a high level. In one or two cases an incompletely successful operation has had the advantage of making amputation possible at a lower level than would otherwise have been necessary. The age of some of the patients (see Table I) may lead the practitioner to suspect senile gangrene rather than embolism. The sudden onset and the unilaterality of the symptoms and signs will usually make the diagnosis clear.

Technique of Operation.

No special instruments are required. Novocain infiltration is the anæsthetic of choice. The incision of the vessel wall, removal of the clot, and suture of the outer coats follow the usual technique of blood-vessel surgery. Liquid paraffin or sodium citrate (1 per cent.) may be used to prevent premature clotting in the wound. The only important advance in technique over earlier methods may be that in cases of embolism at the aortic bifurcation a distal approach is better than a direct. In these exposure of both femorals, which are then lightly clamped and opened, is followed by retrograde catheterization, the clot broken up, and removed through the openings in both vessels. This method is likely to give better results than a transperitoneal operation in a patient who is probably a bad surgical risk, owing to the presence of the heart disease which has furnished the material for the arterial blockage. This method is not only one of absolute precision, but the condition of the patient may make it advisable, although much blood may be lost during the probing. Several cases are recorded in which the thrombus has slipped away when the artery was

exposed. A fresh incision should then be made lower down (for example, over the popliteal vessels). Wounds in arteries are easily sewn up, and one should not hesitate to make multiple incisions if occasion demands it.

The Time Factor.

The early cases are those which do well, and this for very definite and precise reasons. The lodgement of a clot sets up two things which will in a few hours militate against a successful issue. These are: first, endothelial changes which will cause a fresh thrombosis after the clot has been once removed; and secondly, a thrombosis slowly spreads from the original clot and may assume such dimensions as to make complete removal impossible. Within the first five or six hours these untoward effects are not likely to menace seriously the result, but after ten hours at least they become increasingly threatening, so that at the end of twenty-four hours operation will usually be hopeless. It is probable that in the late successful cases already reported complete and absolute obstruction has not been present quite so long as would appear, or that a collateral circulation has in reality saved the limb. If surgery is to achieve a high percentage of successes it must be clearly understood that no cases (save perhaps haemorrhages) are more urgent than these. This lesson will be learned the more easily by reference to Table II, which I have made up from Key's collection (up to 1922), and those successes which have been published since.

TABLE II.—Time Factor. Twenty-eight Successful Embolectomies.

Time.	Key's Series.	New Series (1922-25).	Totals.
	Successes.	Successes.	
From 1 to 5 hours	5	10	15
From 6 to 10 "	4	2	6
From 11 to 15 "	2	1	3
From 16 to 20 "	1	1	2
From 21 to 24 "	1	1	2
Totals	13	15	28

For the sake of completeness the whole series of embolectomies which have been published since Key's paper (so far as I have been able to find them) are given in Table I. These new cases number 28, making, with Key's 45, a total of 73. The highest percentage of good results in the later series has been commented upon above; this amelioration appears to have been due to earlier operation alone. Few of the cases abstracted in the table call for special comment. Only four operations undertaken within ten hours failed. In the nature of things a very high percentage of successes is unlikely ever to be attained, for emboli are apt to be multiple, and further infarction elsewhere will sometimes carry off a patient in whom a local success has been won; moreover, the advanced age of the patient and the frequency of heart disease often make the subjects bad surgical risks.

Olivecrona's case is especially deserving of comment as it bears special testimony to the value of embolectomy. A woman, aged 41, had suffered from valvular heart disease (mitral stenosis) for years. Pulmonary embolism had been observed on several occasions. In July, 1922, she was operated upon successfully by Michaëlsson (Case 3 in Table I) for embolism of the left common femoral. In September, 1923, she suffered embolism of the right common femoral and again success was achieved (Olivecrona, Case 16 in Table I). Six months later the patient was well and no evidences of disturbance of circulation in either leg could be detected. Söderlund's second case illustrates the old and the new methods (Case 27, Table I). A woman of 46 with chronic heart disease had an embolism of the right popliteal artery. No doctor was summoned for two days, gangrene supervened, and supracondylar amputation was performed. The patient was discharged well. Some months later embolism of the left brachial artery occurred. This

time she was sent into hospital immediately, where the embolus was removed, five and a half hours after lodging, with complete success. Two months later she was back at her work making paper flowers. These cases illustrate well the results which may at times be obtained, whilst they also remind us of the possibility or even probability of further embolism in heart cases.

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A METHOD OF NASAL PLASTIC REPAIR BY CARTILAGE GRAFT.

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THE method here described has proved useful in the treatment of nasal deformities, especially those types where depression extends high up, when other measures have been unsatisfactory. A typical case best exemplifies the steps necessary.

A girl, aged 15½ years, was brought to me late in 1923 for the deformity indicated in Fig. 1. When 4 years of age she had had a blow which crushed the nose. No special treatment had been adopted. She had a most disfiguring depression of the middle and upper parts of the nose; the nasal bones appeared to have participated in the damage, and there was marked obstruction

FIG. 1

FIG. 2

from the remains of the septum. The tip of the nose had suffered from atrophy of the septal cartilage, and was sharp, as well as being turned right up by the depression above. The first step was to secure a satisfactory airway, by resecting the shreds of cartilage embedded in fibrous tissue, which represented the remains of the septum, and by freeing the adhesions which had formed between this and the sides of the nose (in front) and the turbinates (behind). When healing was complete this object had been attained, but the appearance was hardly altered.

Four months later, under general anaesthesia, a graft of rib cartilage was inserted to raise the depressed portion. The alar cartilages had escaped, and formed the lower support of the graft; the upper end rested on the remains of the nasal bones.

Description of Operation.

An incision is made in the skin, beginning at a point half-way along the lateral margin of one nostril, running forward along this margin to the anterior end, being carried