The treatment of superficial pigmented scars depends upon the fact that the epidermis and superficial layers of the dermis will regenerate if they are removed, leaving little or no evidence of permanent damage. Sheehan and Swanker (1950) advocate the use of sandpaper for the treatment of superficial scars, and I have found this method, which produces excellent cosmetic results, easy to apply. It is unnecessary to obtain the special boilable waterproof sandpaper which they employ, as ordinary sandpaper can be dry-sterilized in sealed glass jars placed in a hot-air oven at 160° C. for one hour.

In areas in which the pigmentation has penetrated as far as the deep layers of the dermis but not beyond the skin, Iverson (1947) removes the affected layers so far as is possible by sandpapering, relying upon the application of chemical coagulants to complete the removal. I have found this method difficult to control, and prefer to apply the one described by Sheehan and Swanker (1950), in which the affected skin is shaved off with a skin-grafting knife or a scalpel blade.

Anaesthesia.—Local analgesia can be used if the lesions are small, but most cases require general anaesthesia. In cases in which a large area of the face is treated, the use of hexamethonium compounds is of great value, as they not only reduce the blood loss but also provide a clearer field in which to work.

Operation.—If the pigmentation in a given area appears to be superficial, but the exact depth cannot be decided upon, the surface layers should be removed by sandpapering. If this is ineffective the remaining pigmented skin is then removed by shaving, using a skin-grafting knife, or a scalpel-blade if the area is small. In the treatment of pigmented scars which involve the deep layers of the dermis (Fig. 1) successive thin layers of skin are shaved off until a point is reached when the only remaining pigment consists of small areas of fine discrete black dots. At this stage all that is required is the removal of these areas by shaving with a small scalpel blade. In order to reduce to a minimum the amount of skin removed, these areas are picked up in turn between finger and thumb, or by means of a fine hook, and successive fine shavings cut from them until all pigment has been removed. In the event of small pockets of pigment having penetrated deeper than the skin, they are excised at the risk of causing a small amount of scarring, and the defects so caused are closed by suture, care being taken to arrange that their long axes lie parallel to the lines of Langer. Although a perfect cosmetic result is not obtained, the final appearance in suitable cases (Fig. 2) is better than that which follows the use of free grafts to replace the excised pigmented areas.

Many deep pigmented scars which involve the skin and subcutaneous tissues are linear, and can be treated satisfactorily by excision and suture. If after excision of a deep pigmented scar it is found that direct suture is impracticable, the defect is covered either by a local flap or by a free graft, as the case demands.

Summary

Pigmented scars are a common cause of disfigurement after injury. The pigmentation can be prevented by early and vigorous treatment of the initial wounds, and the attention of those concerned with the management of accident cases should be drawn to this fact. The treatment is relatively easy to carry out, in contrast with the treatment of established pigmented scars, which is often difficult.

I wish to thank Mr. W. Hynes for his advice and for permission to publish the cases mentioned in this article. I am also indebted to Dr. J. L. Edwards for the pathological investigations, to Mr. A. O. Jones for the analyses, and to Mr. J. Larway for the photographs.

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ANALYSIS OF 50 CASES OF PERSISTENT DUCTUS ARTERIOSUS

BY

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The possibility of surgical cure of persistent ductus arteriosus was first suggested by Munro in 1907 (see Gross, 1939). Although some unsuccessful attempts had been made before 1939, it was not until that year that Gross successfully accomplished this. Since then several large series have been reported from the U.S.A., but so far there have been relatively few publications on the subject in this country.

Between October, 1947, and September, 1951, 53 patients were admitted to the Thoracic Surgical Unit, Leicester, for ligation of a persistent ductus arteriosus. Operation was performed in 51 instances. Of the remaining two, spontaneous obliteration of the ductus had occurred in a child aged 6 while she was awaiting admission to hospital. The second case was that of a boy aged 12 whose ductus became infected and as a result appeared to have become obliterated by fibrosis; this incidentally cured his infection. One patient who had the classical signs and symptoms of a persistent ductus arteriosus was found at operation to have an obliterated ductus, and an alternative diagnosis of a ruptured sinus of Valsalva was made. The following analysis is concerned with the remaining 50 patients on whom ligation was actually carried out.

Analysis of Cases

Incidence.—In this series there were 45 females and 5 males—a ratio of 9 : 1. This confirms the well-known preponderance of females in this condition, and in fact represents a higher proportion of females than is usual. Brown (1950) collected the figures of several series and obtained an incidence of 2.5 : 1. No selection in favour of females was carried out, and it is difficult to know why the preponderance in this sex was so much higher than usual. The average age at operation was 9 years; the oldest was 40 and the youngest 3 years old.

History.—The age of the parents was known in only 12 instances. In these the fathers' ages averaged 33 years and the mothers' ages averaged 31 years. There were no cases of rubella or other known significant disease during pregnancy, but two of the children were born prematurely. Three patients had a significant family history. In one case the mother had a persistent ductus arteriosus; in another a twin sister (identical twins) also had a persistent ductus arteriosus; and in a third a younger sister died as a baby of congenital heart disease. It is interesting to note, on the other hand, that one of the children with a persistent ductus arteriosus had an identical twin who was quite normal. The affected child was poorly developed compared with her twin, but made rapid progress after ligation of her ductus. In most of these patients the ductus was first diagnosed on routine examination, commonly when first entering school. In only four cases was attention drawn to the ductus by symptoms, although other cases developed symptoms after diagnosis.

Symptoms.—Nine patients complained of dyspnoea at the time of operation; of these, two were in failure and two were infected. Only the patients in failure showed cyanosis; they also had oedema of the legs and palpitation. Those who presented with infective endarteritis had fever, headache, chest pains, enlarged spleen, and in one case aphasia and ataxia. Peripheral manifestations of the end-

arteritis were conspicuously absent; there were no cases of peripheral emboli, with the possible exception of the patient who showed aphasia. Only three patients had red cells in the urine, but several showed evidence of pulmonary emboli. The rarity of peripheral emboli when infection of a ductus occurs is a result of the direction of the blood flow, which is from aorta to pulmonary artery—that is, from high to low pressure. Consequently, blood clot tends to be carried into the lungs. Peripheral emboli may, however, occur under two conditions: (1) when spread of the infection has occurred to the mitral and aortic valves; and (2) when there is reversal of the shunt as a result of pressure changes in the aorta and pulmonary artery. This occurs when congestive failure supervenes.

Blood Pressure.—As would be expected, a high pulse pressure was found (average 64 mm. Hg, highest 90 mm. Hg, lowest 25 mm. Hg). No correlation was found between pulse pressure and the size of the ductus. The exercise test (Bohn, 1938) was carried out in 11 instances only, and produced a diastolic fall in eight and a rise in two. In one case the response was variable. This suggests that, although the test is not infallible, it is a useful means of confirming the diagnosis. Again no clear correlation could be found between the response to exercise and the type of ductus.

Signs.—All the patients had the classical machinery murmur. One patient had been known to have a ductus murmur for many years; when the ductus became infected there were periods when the murmur could not be heard. This could be due to one of two causes—either the ductus was becoming blocked by vegetations (this seems to have happened in the boy previously mentioned) or it might have been due to equalization of pressures as the left ventricle began to fail. There would then be little flow of blood through the ductus. This seems the more likely explanation, since it was observed that shortly before operation the murmur again became difficult to hear, and during that time the patient was cyanosed, suggesting a reversal of the shunt. On the other hand, a machinery murmur was heard in the second patient who was in failure. Although the machinery murmur is a very constant sign in persistent ductus arteriosus, it may be absent in very young children and during cardiac failure; it disappears when the ductus becomes obliterated or blocked by blood clot or vegetations, and, of course, following ligation. On the other hand a machinery murmur may rarely be present in the absence of a persistent ductus arteriosus. It may be heard in unusual sites in a persistent truncus arteriosus or aneurysm of the sinus of Valsalva. A case in which such a murmur was heard is reported by Biörck and Crafoord (1947); it was due to an aneurysmal communication of an anomalous branch of the left coronary artery and a pulmonary artery. In 32 patients a thrill was felt.

X-ray Appearance.—Nineteen patients were thought to have had cardiac enlargement as judged from a simple postero-anterior film. Three of these had associated cardiac defects, leaving 16 cases of pure persistent ductus arteriosus with cardiac enlargement. Of these, five were infected and four probably infected. On the other hand, three infected cases showed no cardiac enlargement. This suggests that cardiac enlargement should make one suspect the presence of infection. Gross enlargement was present in both cases of failure; of these, the patient who was also infected presented the typical picture described by Gilchrist (1945), with a prominent pulmonary artery and patchy consolidation of the lung fields.

Incapacity.—Of the 50 cases of persistent ductus arteriosus, 33 were never incapacitated in any way. One was incapacitated by heart failure, one by palpitations, and nine when they became infected (of these, one developed congestive failure as a result of infection). One woman with an infected ductus had had a child a short time before the diagnosis was made. It is of importance to note that in addition six children had their activities unnecessarily curtailed by their parents. One child of 11, in particular, had never been allowed to go to school. It would seem that parental overanxiety is the second common incapacitating factor in persistent ductus arteriosus.

Congenital Abnormalities.—The following congenital abnormalities were found in association: one case each of spina bifida, left-sided vena cava and arachnoidactyly, interventricular septal defect, subaortic stenosis, narrowed aorta not amounting to coarctation, and possibly a second case of left superior vena cava.

Complications

Seven cases were with certainty infected, and five were probably infected. The following case is of interest in this connexion.

Case 1.—A woman of 25 had been known to have had a ductus arteriosus since childhood. In April, 1951, she began to complain of sweating, chills, and breathlessness. Blood culture produced a growth of *Streptococcus viridans*, and a diagnosis of infected persistent ductus arteriosus was made. Treatment with penicillin brought initial improvement, but she relapsed when that was stopped after six weeks. She was then treated with aureomycin without response. It was found that so long as she was given 600,000 units of procaine penicillin daily she would keep well, except for occasional chills and joint pains. There were no peripheral signs of the infection. Anxiety was occasioned by the intermittent disappearance of her murmur. She began to accumulate oedema and was intermittently cyanosed. It was decided to ligate her ductus in spite of the smouldering infection, and operation was carried out five months after the onset of infection. The ductus was large and friable, but ligation was carried out without any great difficulty. After operation the patient's condition gave rise to anxiety, as her oedema increased and she developed multiple ventricular extrasystoles. She was treated with digitalis and diuretics with steady improvement. For the first time in three months it was possible to stop penicillin without a recurrence of symptoms and elevation of her temperature.

Cardiac failure as the first manifestation is illustrated by the following case.

Case 2.—A woman aged 40 presented with congestive cardiac failure. She was not hypertensive, and gave no history of rheumatic fever. On examination there was a typical machinery murmur, and *x*-ray examination showed marked cardiac enlargement, a prominent pulmonary artery, and congestive changes at both lung bases. There was calcification in the aortic knuckle. At operation the ductus was found to be calcified, and it was tied with tape, as it was feared that a silk ligature would break it. After operation there was rapid improvement in her condition and she was able to lead an unrestricted life.

Operation

The postero-lateral approach was used in all cases. Ligation with heavy silk was carried out in most of them, two ligatures being used in two grooves. Where possible, a few drops of 50% glucose solution were injected between ligatures to promote fibrosis of the ductus. In no case was division attempted. In most instances no difficulty was experienced. In three cases bleeding occurred from the ductus; two of these were infected, and once there was considerable bleeding from a large pulmonary artery. Excessive oozing occurred in three cases. On every occasion bleeding was fairly easily controlled.

Controversy exists regarding the merits of simple ligation as compared with division of the ductus. As early as 1939 Gross stated his belief that division would be preferable, but at that time thought it would not be feasible. He points out that ligation in continuity of a vessel is against all accepted principles of vascular surgery. Shapiro (quoted by Potts *et al.*, 1949) collected 643 cases of persistent ductus arteriosus operated on by 46 surgeons; of these, 8.7% recurred. Wangensteen *et al.* (1949) report two recanalizations out of 16 ligations. In view of these figures many surgeons now prefer to divide and suture the ductus. That recanalization is not impossible even then is shown by a case of Crafoord's (1948). Ligation is still the operation carried out by many surgeons, including Blalock (1946). It is preferred in this unit, as it would appear to be a safer

procedure. So far there have been no recurrences among the 50 cases operated upon. Naturally the number of recurrences will depend on the criteria accepted in diagnosing such an event, and a minimal leak may produce marked signs. Hence the figures quoted above may exaggerate the incidence of recanalization following simple ligation. It should be noted that a systolic pulmonary murmur often persists for some time after ligation, presumably as a result of dilatation of the pulmonary artery.

Although on the whole no particular anxiety was felt during most operations, the dramatic and serious events in the following case make it worth recording.

Case 3.—The patient, a girl aged 13, had suffered no symptoms, though she was mentally rather backward. Operation was carried out under thiopentone, followed by nitrous oxide and oxygen and a procaine drip. Immediately the chest had been opened it was noticed that there was practically no bleeding. The heart was inspected. The auricles were seen to be contracting irregularly, while the ventricles were at a standstill. Cardiac massage was begun at once, followed by intracardiac adrenaline. The ventricles resumed beating immediately, and continued to do so strongly and regularly. It was estimated that they had been standing still for two to three minutes. It was decided to proceed with the operation, and this was carried out without further difficulty. After operation the patient was given cytochrome C, 2 pints (1.1 litres) of quadruple-strength plasma, and sodium succinate. She continued unconscious for two days in an attitude resembling decerebrate rigidity. A hopeless prognosis was given to her parents; nevertheless she regained consciousness and entered a period of restlessness lasting about ten days. Henceforth her mentality improved slowly, though it was many weeks before she could feed herself and had regained continence. Six months after operation she returned to school, though she has difficulty in coping. Nevertheless she appears to be improving.

An exactly similar case is described by Wangensteen *et al.* (1949). One must conclude that it is well worth while to persevere in the treatment of such cases, which in the early stages would appear to be utterly hopeless.

Post-operative Course

One boy aged 6 died two days after operation. He was a typical case of persistent ductus arteriosus, and operation was straightforward. On his way to the ward he was allowed to become cyanosed, and this was not discovered for some time. Although he eventually recovered consciousness he died of cerebral anoxaemia after two days. This death is directly attributable to a shortage of trained nursing staff. One patient had a mild wound infection which cleared rapidly. Four patients developed pleural effusions which cleared completely. One patient had a pulmonary infarct; this was one of the infected cases. Two patients required bronchoscopy for post-operative lung collapse, and one patient produced four or five tracheal casts.

Follow-up Period

This has been up to four years, and there have been no recurrences. The woman aged 40 who was in failure recovered completely—this being one of the few types of cardiac failure in which complete recovery is possible. The infected cases all recovered completely, irrespective of the use of antibiotics. In most cases, however, an attempt was made to cure the infection first by the use of large doses of penicillin. The children who were handicapped by the knowledge of heart disease have all returned to a normal life.

Summary and Conclusion

Fifty cases of ligation of persistent ductus arteriosus, with one death, are analysed. Ten physically handicapped patients made a complete recovery, and six who were held back by the knowledge of heart disease were allowed to return to normal life.

No certain knowledge is available to show how many of the asymptomatic cases, had they been left alone, would have gone on to obliteration of the ductus. It is well known that persistent ductus arteriosus is uncommon in the elderly, and this is sometimes taken as proof of the poor prognosis of the condition. On the other hand, it may mean that obliteration does occur more often at a later age than is at present recognized. Nevertheless, operation seems well justified in view of its low mortality as compared with the dangers of a persistent ductus—mainly subacute bacterial endarteritis and cardiac failure. In some cases the accelerated growth and development following operation are striking. For these reasons operation should not be too long delayed, and about 7 years probably represents a good age to operate.

My thanks are due to Mr. G. L. Cruickshank, who carried out the operations, for permission to publish this series.

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REDUCTION OF POST-OPERATIVE PAIN

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The object of this communication is to present a simple way of diminishing post-operative pain in abdominal incisions. Briefly, analgesia is obtained by injecting procaine every three hours into the rectus sheath through polythene tubes for a period of three days. The method was first used by Blades and Ford (1950) in chest operations, and they suggested that it might prove successful in abdominal surgery. It was subsequently employed by Gerwig, Thompson, and Blades (1951) in 24 patients undergoing cholecystectomy. These writers came to the conclusion that it guaranteed satisfactory analgesia in upper paramedian incisions.

Pain is the chief factor preventing full respiratory excursions and adequate coughing after abdominal operations. Pain can be diminished by morphine, but morphine has an inhibitory effect on the cough reflex, and this may cause pulmonary complications sufficient to endanger a patient who has had an operation such as partial gastrectomy. Pooler (1949) found that pulmonary complications occurred in 19% of patients after upper abdominal operations. Using a spirometer, he found that there was a great diminution in vital capacity. He came to the conclusion that reflex muscle spasm was the chief cause of this reduction, and something more than the abolition of conscious pain was required. This could be accomplished only by interrupting the reflex arc on the afferent side.

Present Investigation

We were led to try the method of local infiltration with procaine, with a few modifications, after observing the reactions of a healthy young man who developed pulmonary collapse following a simple laparotomy through an upper paramedian incision. He had a great deal of pain in the