

apparent cause. She also complained of nervousness, attacks of "shaking" and acroparæsthesia. She usually felt very cold but was also subject to "hot flushes." The hands were very blue. All these symptoms had come on gradually during the past few years. Since the age of 18 years she had been liable at times to go off into a trance lasting one or two hours, sometimes several times a day. Her teeth were bad and I thought it wise first to have these attended to and the digestion improved by bismuth and diet. On Nov. 4th, 1902, I gave her calcium chloride (a remedy known to increase the coagulability of the blood), 20 grains thrice daily and nothing else but confection of senna once daily. The note two weeks later is that the "attacks of trance and other nerve symptoms are better; formerly one or two a day in series, lately none since taking med." But the digestion was upset and I had to return to the old medicine for a time. On Nov. 17th, 1903, I added extractum ergotæ liquidum (20 minims) to the medicine. This gave her very marked relief from the nervous symptoms. On Jan. 25th, 1904, it was noted that she was "so much better that she is taking the ergot medicine only once daily. The hands go white now instead of red." And for some time she ceased attending regularly. She still comes from time to time and whenever the ergot has been administered the nervous symptoms have ceased and they are now gradually disappearing. The case is interesting in this respect and also by the marked effect which the calcium chloride had upon the attacks of trance. Ichthyol, atropin, thyroid gland, and ovarian extract are also remedies which I have employed in various circumstances; but I hope to return to this subject on another occasion.

(e) Educational and other prophylactic measures are of great value when we remember the hereditary and inherent nature of this complaint. With careful education hysterical subjects may reveal brilliant intellects and a large proportion of them may become most useful and energetic members of the community. But when allowed to pass through a rigid form of schooling and to drag out a weary existence—circumstances commonly met with in the lower orders—they tend to gravitate into the workhouse, the brothel, or the prison. The cultivation of the will and of self-control is the central point in their education, so that the unruly reflex centres and emotions may meet their master in additional self-control. These children should be energetically, though with tact and kindness, taught to bridle their passions and to neglect small disagreeable sensations. It is of no use to get angry with them and call them shams; remember we are dealing with an individual of different nervous organisation and temperament from the average type.

The diet should be of the plainest and least stimulating kind, the life regular and free from any kind of excitement, and as much time as possible spent out of doors in contact with the grand but simple phenomena of nature. Nothing can be worse for these girls than the whirl and bustle of town life, nothing can be better than moderate exercise, bicycling, riding, or swimming. The question of sports where the exciting element of competition comes in must be carefully considered.

As age advances any tendency to introspection should, as far as possible, be quietly corrected, and especially by the cultivation of interests outside self. But, in guiding these people towards such counter attractions, screen them, as far as possible, from undue religious exercises and love affairs—two fatal directions which their fancies are very apt to take. On the other hand, the cultivation of the gentler qualities, pity, self-sacrifice, and work for others, leads to the formation of character and the self-control we desire. These people are often extremely selfish and if you can only cultivate unselfishness half the battle is won—self-control will surely follow.

If hysterical manifestations appear the patient should certainly be removed for a time from the family circle. I have sometimes found this alone sufficient to effect a cure. And even before any outbreak occurs it may be desirable, especially when the mother of the patient, as so often happens, is of an hysterical type, to consider the advisability of removing the girl or boy to the care of a judicious teacher or a suitable family. In these cases you will often be confronted with an unfortunate incompatibility between mother and daughter which will counteract all the good of the most careful education. Marriage, if suitable and happy, may prove to be the redemption of these subjects, not, as I

have so often insisted on, by the gratification of the sexual passions, but by removal from incompatible surroundings, by giving to the patient fresh interests outside herself, and by the cultivation of unselfishness.

## TWO CASES OF EXCISION OF RUPTURED SPLEEN.

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*With an Account of the Blood Changes in the Second Case by  
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CASE 1, by E. W. ROUGHTON.—The patient, a child, aged seven years, was run over by a light van on Jan. 5th, 1906. On admission to hospital shortly after the accident she was found to be much collapsed, was pale and restless, the extremities were cold, and the pulse-rate was 120 per minute. Muddy marks on the clothing showed that a wheel had passed over the abdomen. I saw the child three hours after admission and found that the shock was still intense. The abdominal wall was hard and moving but little with respiration. Nothing else abnormal was detected. Feeling sure that there was some severe intra-abdominal injury, I decided to explore at once. On opening the abdomen a large quantity of dark-coloured blood escaped. The liver was intact but the spleen was found to be ruptured and in a pulpy condition. A ligature was passed round the gastro-splenic omentum and the remains of the spleen were removed. There were several loose bits. The peritoneum was sponged dry of blood and was filled with hot saline solution. The abdominal wound was closed as quickly as possible, only one layer of sutures being employed. During the operation saline solution was infused into the median basilic vein. The patient was much collapsed when she was put back to bed. Subcutaneous saline infusions were used during the next two days. For a week after the operation the temperature varied from 100° to 101° F. and the pulse from 120 to 140. Afterwards convalescence was only interrupted by a slight febrile attack on Feb. 10th and 11th, the cause of which was not ascertained. The patient was discharged on March 2nd.

The child was kept under observation until Dec. 4th, 1906. At no time was there any discoverable enlargement of lymphatic glands or alteration in the bones. The blood changes during the patient's stay in hospital are summarised in the subjoined table. The last column of the table gives a differential count of the white corpuscles nearly a year after the operation. The child was seen again in June, 1907: she then had some enlargement of the glands in the axillæ, groins, and on both sides of the neck. Her general health was quite good.

CASE 2, by T. P. LEGG.—On Nov. 25th, 1903, a little girl, aged 12 years, was admitted to the Royal Free Hospital. It appears that at 9.30 P.M., whilst running in the street she fell against the kerbstone, striking the front of her abdomen. She went home and fainted. At 10 o'clock she was brought to the hospital. The child was in a good deal of pain; there was no evidence of any injury to the abdominal contents nor any bruising of the parietes. The pulse was 88 per minute. At midnight she was sleeping quietly, lying on her right side. The pulse had not increased in frequency; further examination did not reveal anything abnormal. During the night the pulse became more frequent hour by hour and next morning at 11 o'clock it was 128. The abdomen, which had become slightly distended, was distinctly rigid and tender on palpation, especially to the right of, and at the level of the umbilicus, where there was also slight discolouration of the skin. At this place there was an impairment of the percussion note; both flanks were resonant. The liver dulness was present. There had been no vomiting for several hours. The urine was normal. There was no marked facial pallor and the child was not restless. It seemed clear that some serious injury had resulted from the fall, the diagnosis lying between hæmorrhage and a rupture or severe bruise of the bowel. Exploratory laparotomy was performed,

A SUMMARY OF THE BLOOD CHANGES IN CASE 1 DURING THE PATIENT'S STAY IN HOSPITAL, WITH A DIFFERENTIAL COUNT OF THE WHITE CORPUSCLES NEARLY A YEAR AFTER THE OPERATION.

	Jan. 11th.	Jan. 16th.	Jan. 20th.	Jan. 31st.	Feb. 8th.	Feb. 28th.	Dec. 4th.
Hæmoglobin ... ..	40 per cent.	45 per cent.	50 per cent.	52 per cent.	56 per cent.	69 per cent.	—
Red corpuscles ... ..	3,300,000	3,300,000	3,500,000	4,200,000	4,200,000	4,800,000	—
White corpuscles ... ..	29,000	26,000	21,000	18,000	19,000	10,000	10,700
Colour index ... ..	0.60	0.66	0.71	0.62	0.67	0.70	—
Polymorphs ... ..	79.0 per cent.	67.0 per cent.	71.0 per cent.	70.0 per cent.	65.0 per cent.	56.0 per cent.	36.5 per cent.
Eosinophiles ... ..	0.4 „	1.4 „	2.1 „	1.2 „	0.7 „	1.0 „	4.0 „
Lymphocytes ... ..	16.0 „	27.0 „	22.0 „	26.0 „	29.0 „	40.0 „	57.0 „
Myelocytes ... ..	1.2 „	1.0 „	0.5 „	0.3 „	0	0	0
Nucleated reds ... ..	2	10	0	0	0	0	0

an incision three inches long being made at the level of the umbilicus through the right rectus muscle, at the place where the rigidity was most marked and where the discolouration of the parietes existed. On opening the peritoneal cavity the omentum, infiltrated with blood, presented, and a large amount of dark blood with a few clots was evacuated. The incision was prolonged upwards to the right costal margin and the liver examined; it was found to be uninjured. The hand was at once passed across to the spleen which was felt to be extensively lacerated. A transverse incision across both recti muscles was then made, converting the former into a T-shaped incision. The spleen was readily brought up into the wound and the pedicle grasped by the fingers of the left hand. Around the hilum there was a large quantity of clot. The organ was freed from its peritoneal attachment, and a pedicle composed of the splenic vessels was formed and transfixed by three interlocking sutures, which were tied separately. Whilst the pedicle was being tied the respirations became hurried. The peritoneal cavity was washed out with sterilised salt solution, one and a half pints being left in it and one and a half pints being given intravenously during the operation. The wound was closed by interrupted silkworm-gut sutures passed through the whole thickness of the abdominal wall. The operation was well borne and six hours later the patient was quite comfortable. The pulse was 128 and irregular, three or four beats coming close together. A blood count was made; the red cells were 3,652,000, the whites 21,000, mostly polynuclear, and the hæmoglobin 63 per cent. The temperature was 100.8° F. On the 27th (the day after the operation) there was considerable abdominal distension but no rigidity. She had vomited frequently but only small amounts. The pulse at 6 P.M. was 154, of small volume and irregular, and the temperature was 101°. There was no restlessness. The bowels were well opened and on the 28th there was a marked improvement in the child's condition in every respect. From this time convalescence was uninterrupted and on Dec. 10th most of the stitches were removed, the wound having healed by primary union except at one place where the edges had not been sufficiently carefully approximated. She left the hospital quite well on Jan. 14th, 1904, having been kept in for purposes of observation. During the whole of this time repeated examinations of the lymphatic glands were made. On Nov. 27th a slightly enlarged gland above the left clavicle and on the 28th another in the axilla were found. They were never bigger than a pea. Later the glands in the right axilla and some in the posterior triangle of the right side were perceptible. These glands were never big and there was certainly none of the marked general enlargement of the lymphatic glands which has been noticed to follow the removal of the spleen in so many cases. There was never any tenderness in the long bones nor any enlargement of the thyroid.

A noticeable feature of the pulse was the manner in which two or three beats would come close together, and then for a time the beats would be quite regular. In the course of a few days this irregularity quite disappeared. The quantity of urine passed during the first 24 hours after the operation was 25 ounces, on the second day 25 ounces were passed, on the fourth day 46 ounces, and on the fifth day 36 ounces. During the next week the average daily amount exceeded 40 ounces. On two occasions the urea was estimated and was found to be 1.8 per cent. and 2.2 per cent. respectively. On Dec. 10th the patient had severe abdominal pain; this was probably due to intestinal disturbance secondary to a

purgative. An enema resulted in a good motion and cessation of the pain. Severe griping abdominal pains have been noticed in several cases after removal of the spleen and are said to be due to the rapid enlargement of the mesenteric glands. With the exception of this attack the patient had not any abdominal pain and at no period could anything abnormal be felt in the abdomen. At the present time, more than three years after the accident, the patient is in perfect health.

*Remarks by Mr. LEGG.*—Injuries of the spleen may be divided into two classes: (1) those without any external wound, and (2) those with an external wound accompanied by prolapse of the organ through it. The second group of cases will not be considered in the remarks which follow.

1. *The onset of the signs and symptoms.*—In the first case evidence of a serious intra-abdominal catastrophe was soon forthcoming. In the second more than 12 hours elapsed before there was evidence of anything seriously wrong. The hæmorrhage may have taken place slowly or have ceased for a time and then recurred, or the irritation of the peritoneum by the blood may have set up the severe symptoms. The fainting which the child suffered from soon after the accident was probably due to severe pain or shock. A similar delay<sup>1</sup> has been observed in many other cases. The actual amount of damage sustained by the organ has not a little to do with the rapidity of the onset of the signs. In our first case the spleen was pulped and in the second there were two fissures on the diaphragmatic aspect—one just below the middle line extending completely across the organ and the other a much shorter one nearer the upper pole at the anterior border. The splenic vessels<sup>2</sup> may be lacerated; when this occurs the hæmorrhage is likely to be very severe. Direct blows would appear to cause more frequently laceration, whilst a crush, as by a wagon, more often leads to pulping and disintegration.

2. *The nature of the injury.*—This varies from comparatively slight accidents, as a fall of a few feet, to a severe crush, such as being run over. Kicks and blows on the left side of the abdomen are not infrequent causes. There is frequently not any bruising or other signs of external violence, which emphasises the importance of putting all patients to bed after an abdominal injury has been sustained and carefully watching them, the pulse being taken regularly at not longer intervals than an hour.

3. *The site of the pain and the area of dulness.*—These are of so much importance in the diagnosis of abdominal injuries, and as the site of the operation is largely dependent on their position they are worthy of careful attention. In our first patient the child was in such profound shock as to be unable to feel pain and there was no area of dulness detected. In the second case the area of dulness, the most intense pain, and rigidity were to the right of the umbilicus. In many cases of ruptured spleen the greatest pain and tenderness have been found in the left hypochondriac and epigastric regions, with dulness in the same regions and in the left lumbar space. It is also to be remembered that there may be a very large amount of blood in the peritoneal cavity without any dulness being elicited on percussion, as in our first case.

4. *Methods of treatment.*—There are three methods of dealing with a ruptured spleen—(a) to suture the lacerations,

<sup>1</sup> Ballance: Practitioner, vol. ix., 1898. Burrows: THE LANCET, Feb. 18th, 1905, p. 424. Savor: Centralblatt für Gynäkologie, 1893, No. 48.

<sup>2</sup> Heaton: Brit. Med. Jour., vol. ii., 1899.

(b) to remove the organ, or (c) to pack with gauze. Each method has been successfully used. As regards the use of sutures they are not often applicable for the following reasons. 1. The size, number, and situation of the lacerations. It would seem to be scarcely possible to unite together sufficiently accurately two nearly separate portions. From their situation it may be impossible to reach all the lacerations and the time occupied in uniting the torn surfaces would be very considerable. Moreover, these

permanently arresting the hæmorrhage which can be temporarily controlled by grasping the pedicle with the fingers or by forceps. Two or three interlocking ligatures may be required. The pedicle should be divided as far from the ligatures as possible, a portion of the spleen being left behind if necessary. At the moment of tying the pedicle, there may be a change in the pulse and respiration. The hæmorrhage may have ceased at the time the operation is being performed, either because the patient is very collapsed

TABLE I.—SHOWING NUMBER OF CORPUSCLES, HÆMOGLOBIN, ETC.

	1903.										
	Nov. 26th	Nov. 27th	Nov. 28th	Nov. 29th	Nov. 30th	Dec. 1st	Dec. 2nd	Dec. 3rd	Dec. 4th	Dec. 7th	Dec. 9th
Red corpuscles ... ..	3,652,000	3,700,000	3,080,000	2,900,000	2,824,000	3,140,000	3,720,000	3,800,000	3,750,000	3,900,000	3,960,000
Hæmoglobin ... ..	63%	68%	—	—	60%	63%	—	70%	72%	72%	75%
Colour index ... ..	0·86	0·9	—	—	1·06	1	—	0·9	0·96	0·94	0·94
Leucocytes ... ..	21,040	20,400	23,360	13,400	13,200	10,000	13,500	16,700	14,900	17,000	16,800

TABLE I. (continued).

	1903.							After-history.			
								1905.			1906.
	Dec. 10th	Dec. 11th	Dec. 14th	Dec. 15th	Dec. 17th	Dec. 21st	Dec. 24th	March	April	October	Dec.
Red corpuscles ... ..	3,950,000	3,920,000	4,000,000	4,004,000	4,112,000	4,200,000	4,312,000	5,930,000	6,656,000	6,024,000	5,000,000
Hæmoglobin ... ..	75%	75%	78%	80%	80%	82%	84%	75%	86%	102%	100%
Colour index ... ..	0·94	0·94	0·97	1	0·96	0·94	—	0·63	0·64	0·84	1
Leucocytes ... ..	17,000	11,500	7,800	8,200	7,200	8,000	10,000	12,000	7,600	14,800	8,800

TABLE II.—SHOWING THE RESULT OF THE PERCENTAGE COUNTS OF THE LEUCOCYTES.

	1903															After-history.				
																1905.			1906.	
	Nov. 26th	Nov. 27th	Nov. 28th	Nov. 29th	Nov. 30th	Dec. 1st	Dec. 2nd	Dec. 3rd	Dec. 4th*	Dec. 7th	Dec. 9th	Dec. 10th	Dec. 11th	Dec. 15th	Dec. 17th	Dec. 24th	Mar.	April	Oct.	Dec.
Polynuclears	91·25	90·25	81·2	70	72·25	65·25	68·5	53·5	58·25	64	74·25	61	55·5	45·25	50	38·4	48·25	44·2	58·75	54
Small lym- phocytes ... }	4·25	7·3	15·8	28·4	21·5	28	5·5	7·5	11·75	9·25	6	16·5	16·75	19·75	24	50·4	17	—	32	37
Large lym- phocytes ... }	3·25	1·25	0	0·3	0	0·5	9	24·75	23·25	19	10·5	8·5	8·25	29·5	21	8	7·5	—	3·75	6·25
Hyaline cells	1·25	1·2	3	0·8	5·5	5	14·25	10·25	3·75	5	7·75	11·5	16·5	2·75	1·75	1·6	25	—	1·25	1·5
Total mono- nuclears ... }	8·75	9·75	18·8	29·5	27	33·5	28·75	42·5	47·5	33·25	24·25	36·5	42·5	52	46·75	60	49·75	54·2	37	44·75
Eosinophiles	0	0	0	0·5	0·75	1·25	2·75	4	3	2·75	1·5	2·5	3	2·75	3·25	1·6	2	1·6	3·75	1·25

\* Two myelocytes seen.

TABLE III.—SHOWING THE TOTAL NUMBERS OF THE DIFFERENT FORMS OF LEUCOCYTES.

	1903.															After-history.				
																1905.			1906.	
	Nov. 26th	Nov. 27th	Nov. 28th	Nov. 29th	Nov. 30th	Dec. 1st	Dec. 2nd	Dec. 3rd	Dec. 4th	Dec. 7th	Dec. 9th	Dec. 10th	Dec. 11th	Dec. 15th	Dec. 17th	Dec. 24th	Mar.	April	Oct.	Dec.
Polynuclears	19199	18411	18968	9380	9537	6525	9247	8934	8679	10880	12474	10370	6382	3710	3600	3840	5790	3359	8795	4752
Small lym- phocytes ... }	894	1489	3690	3805	2838	2800	742	1252	1750	1572	1008	2805	1926	1622	1728	5040	2040		4736	3256
Large lym- phocytes ... }	683	255	0	40	0	50	1215	4133	3464	3230	1764	1445	948	2419	1512	850	900	4119	555	550
Hyalines ...	263	244	700	107	726	500	1925	1711	558	850	1302	1955	1897	225	126	160	3000		185	132
Eosinophiles	0	0	0	67	99	125	371	668	447	467	252	425	345	225	234	160	240	121	555	110

patients are not in a condition to stand a prolonged operation. 2. The hæmorrhage may be temporarily arrested but when the shock passed off it would be not unlikely to recur, the stitches not holding in the friable spleen or cutting out owing to the variations in size of the organ which normally occur.

Removal of the injured spleen is the best method of treatment in the majority of cases and is the surest way of

or there is a good deal of clot about the hilum, or the pedicle itself is being stretched in bringing the organ into view.

There does not seem to be anything to recommend packing with gauze, especially as removal of the organ has been shown to be quite compatible with perfect health.

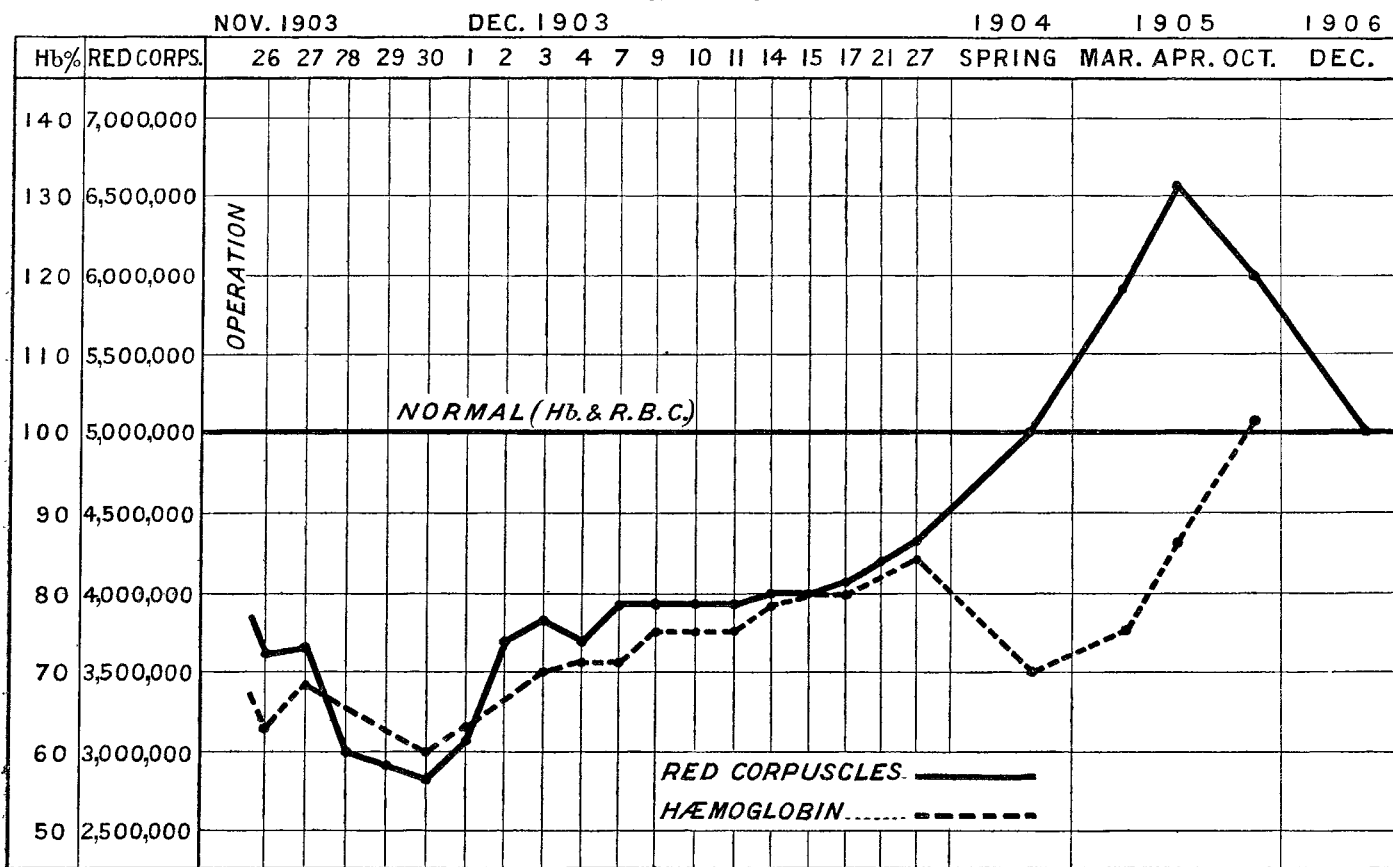
5. *Effects of removal of the healthy spleen.*—These can be studied from the numerous cases which are now on record.

In many instances the patient has made an excellent immediate recovery from the operation and subsequently, after a varying interval of time, serious symptoms have developed. The patients may be divided into three classes: (1) those in whom convalescence and recovery is complete and rapid; (2) those in whom serious symptoms develop and persist for a time, being followed by a complete restoration to health; and (3) an intermediate group characterised by enlargement of the lymph glands, anæmia, some enlargement of the thyroid, and emaciation, a rapid recovery following. Age does not appear to have any determining influence as regards the onset of the symptoms. It would appear that in children recovery is generally rapid, as in these two patients.<sup>3</sup> In neither of them was an accessory spleen found, as has been sometimes observed. The symptoms which have followed the operation are: (1) rapid emaciation and weakness; (2) great thirst; (3) persistently rapid pulse; (4) intermittent elevation of temperature; (5) great anæmia; (6) drowsiness, peevishness, and irritability of temper; and (7) griping abdominal pain.<sup>4</sup>

same apparatus and all were made by myself. The red corpuscles were counted with a Thoma-Zeiss hæmocyto-meter, special precautions being taken to ensure accuracy. For the hæmoglobin a Haldane's hæmoglobinometer was employed, the same apparatus being used throughout. The leucocytes were counted in the same preparation as the red corpuscles, using the field method and working with a field eight squares in diameter, as described in my "Clinical Bacteriology and Hæmatology."<sup>5</sup>

The differential counts were made in all cases on films stained by Jenner's stain and only perfect and well-stained films were used; in a few cases the results were checked with triacid stain. From 500 to 1000 leucocytes were counted and in some cases the counts were repeated and the results were compared. It was found that the correspondence was not always as close as could have been wished; this was due to the fact that the mononuclear cells (the lymphocytes and hyalines) showed an unusually great range of variability, so that the class to which a cell should belong was often uncertain. The results given in Table II. were obtained with considerable care and probably represent a

CHART I.



Showing red corpuscles and hæmoglobin.

An Account of the Blood Changes in the Second Case, by W. D'ESTE EMERY.

As it has been held that some theoretical questions of great importance might be solved by a careful examination of the blood after splenectomy, and as this did not seem to have been done in any reported case, we resolved to carry out a full series of researches in this case; it was extremely suitable for this purpose, since the patient was apparently quite healthy before the operation, the spleen removed at the operation was quite normal and the patient recovered without presenting any complications. In all 23 examinations of the blood have been made, 18 being within a month of the operation, one during the next year, three in the second, and one in the year after; the observations thus cover a period of three years, during the whole of which time the patient remained in perfect health and underwent the normal physiological growth of this period.

The counts were, with hardly an exception, made with the

close approximation to the truth. The results of the counts are given on Tables I., II., and III.

Red corpuscles and hæmoglobin (see Chart I.).—The first count was taken four hours after the operation and by this time the hæmorrhage had reduced the red corpuscles to 3,652,000 and the hæmoglobin to 63 per cent. The colour-index at this time was 0.86, but we are unable to suggest a reason why it should be below normal unless the patient was slightly chlorotic at the time of the accident. The second examination showed a rise, slight as regards the number of corpuscles but pronounced as regards the amount of hæmoglobin; this phenomenon is not uncommon after severe operations and is probably due partly to the restriction of fluids and partly to the defective circulation and consequent stagnation of blood in the capillaries. It has no relation to the absence of the spleen. The secondary fall beginning on the day after the operation and lasting until the fifth day (Nov. 30th) is also a normal phenomenon, and is due to the absorption of fluid to replace that lost by the hæmorrhage; the reduction is brought about simply by a dilution of the blood that remains. It will be seen that the lowest figures met with were 60 per cent. of hæmoglobin and

<sup>3</sup> Ballance: Loc. cit. Haynes: Annals of Surgery, vol. xl., 1904.  
<sup>4</sup> Heaton: loc. cit. Burrows: loc. cit. Ballance and Pitts: Transactions of the Clinical Society of London, vol. xxix., 1896.  
 J. Rutherford Morison: THE LANCET, Jan. 7th, 1899, p. 27. Beaumont and Houseman: THE LANCET, Sept. 13th, 1902, p. 744. Bolton: Annals of Surgery, vol. xxxi., 1900.

<sup>5</sup> Lewis's Practical Series, 1906.

2,824,000 red corpuscles, indicating that some two-fifths of the total volume of the blood had been lost; this is a very considerable amount and one which may cause a severe strain on the organs of blood production, so that in a weakly person such a loss may be followed by anæmia of long duration. The process of regeneration appears to have commenced by the sixth day after the operation, which shows an increase of 3 per cent. of hæmoglobin and 300,000 red corpuscles over the preceding day. By the next day the increase was much more marked, the gain in red corpuscles during this period of 24 hours being 600,000, so that there was an increase of 900,000 during 48 hours. (It should be noted that the counts were made in nearly all cases at the same hour of the day.) From this point (the seventh day) there was a gradual and steady rise of both the corpuscles and the hæmoglobin, until the counts ceased on Dec. 24th, nearly a month after the operation. The red corpuscles were replaced slightly more rapidly than the hæmoglobin, so that the colour index was usually a little below normal; this is, of course, the normal process of regeneration. Lastly, a few normoblasts were found in the films during the second week—i.e., at the period of most rapid regeneration. It is interesting to note that a few myelocytes were seen at the same time, indicating great functional activity of the bone-marrow about this period. All these phenomena are quite normal and serve to indicate that the blood regeneration proceeds in an absolutely normal fashion after splenectomy. This appears to have been noted by the other surgeons who have performed the operation, to judge from the somewhat scanty data at our disposal. Thus in Pitts's and Ballance's<sup>6</sup> first case the regeneration was at the rate of 30,000 red corpuscles per day, in their second 20,000, and in their third 50,000. In another of Ballance's cases<sup>7</sup> the regeneration (taken from the date of operation to a month afterwards) was 45,000 per day, though, as in our case, the earlier stages were much more rapid. The loss of blood in these cases was not quite so great as in ours, the minimum being 3,333,333, 3,730,000, 3,590,000, and 3,280,000 respectively, whereas ours was 2,842,000. The hæmoglobin is not given in these cases except in Ballance's, but here it seems certain that some error must have crept in, since the figure never fell below 83 per cent. even when the red corpuscles were reduced to about 3,000,000. In Regnier's case, in which the hæmorrhage was very severe, the hæmoglobin fell to 20 per cent. and the red corpuscles to 2,500,000. The former reached 80 per cent. and the latter 4,700,000 in eight weeks—a formation of about 1 per cent. of hæmoglobin and 40,000 red corpuscles per diem.

The subsequent history of the case from the point of view of the red corpuscles is of some interest. An examination was made in the spring of the subsequent year (about four months after the operation) and there was found to be a slight grade of anæmia of the chlorotic type. The exact figures have unfortunately been mislaid, but the red corpuscles were approximately normal in numbers and the hæmoglobin reduced to about 70 per cent. A year after (in March, 1905, 16 months after the operation) the figures were: red corpuscles, 5,900,000 per cubic millimetre; hæmoglobin, 75 per cent., showing a decided increase in the number of red corpuscles, whereas the regeneration of the hæmoglobin had remained almost at a standstill, the amount being 10 per cent. less than a month after the operation. Considering that the onset of puberty probably took place at or about this time it is not at all improbable that this reduction (in which the colour index fell to 0.63) was of a genuine chlorotic nature.

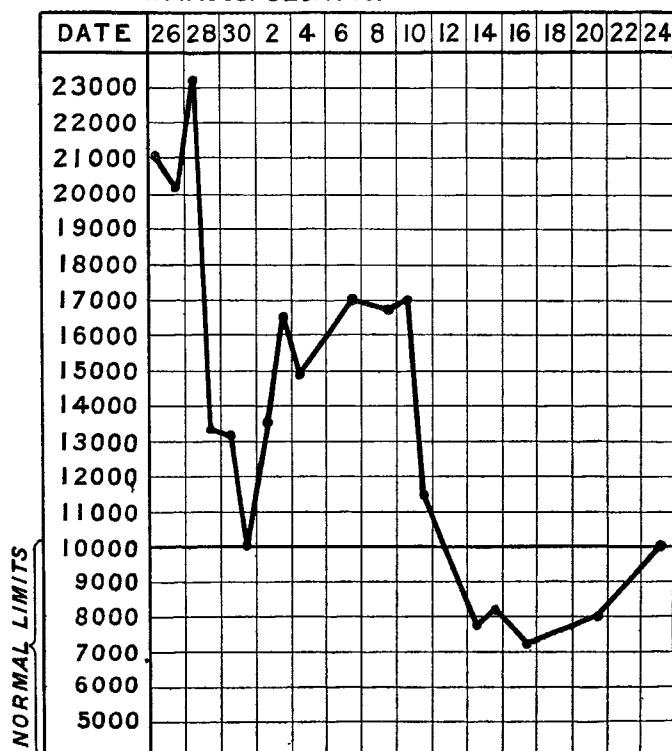
In the following month (April, 1905, 17 months after the operation) the polycythæmia had increased to a remarkable extent, the red corpuscles numbering no fewer than 6,656,000 per cubic millimetre, the hæmoglobin being 86 per cent., and the colour index 0.64. The morphology of the corpuscles showed no deviation from the normal and there were no normoblasts or other abnormal corpuscles to be seen. We can suggest no explanation of these results, which do not appear to have been noticed previously in other cases. Six months subsequently to this the polycythæmia was still marked, though less than on the previous count. The red corpuscles were 6,000,000 and the hæmoglobin had by this time reached normal (102 per cent.), though the colour index was still low. It is obvious that these three counts happened luckily enough to have

been taken at a time when some remarkable crisis occurred with regard to the formation of the red corpuscles and hæmoglobin, for in this period of seven months the hæmoglobin, which we may assume to have stood at about from 70 per cent. to 75 per cent. during the 16 months the patient had been out of the hospital, rose from 75 per cent. to 102 per cent., a gain of 27 per cent., whilst the corpuscles attained a maximum of 6,600,000 and then gradually sank. It is a little unfortunate that we have no counts immediately before and after this period. Our last count was made in December, 1906, almost exactly three years after the operation, and showed a perfectly normal condition of the blood so far as the red corpuscles and hæmoglobin were concerned: corpuscles, 5,000,000; hæmoglobin, 100 per cent. It is probable, therefore, that during the last 14 months the hæmoglobin had remained at its normal level, whilst the number of corpuscles had steadily sunk.

*The leucocytes.*—1. Total numbers (see Chart II.). The

CHART II.

NOV. 1903. DEC. 1903.



Showing the total number of leucocytes.

first count, immediately after the operation, showed a high leucocytosis which, as the differential count showed, was due entirely to an increase in the polynuclears. It remained nearly at the same level for two more days, the maximum of 23,000 being reached on the third day, about 50 hours after the operation. This leucocytosis was similar to that usually met with after severe injuries or extensive aseptic operations and does not present any point of interest. It rapidly diminished, and by the sixth day the numbers had regained a high normal level (10,000). At this period there was a secondary rise, lasting ten days (until Dec. 10th) followed by a rapid fall to normal (reached about the twelfth day) and attaining at its maximum a total height of 17,000 leucocytes per cubic millimetre. Subsequently to this the figures ranged between normal limits until the time when the examinations ceased on Dec. 24th, 1903. Our subsequent counts show that the total number of leucocytes was raised two years after the operation (October, 1905), though on one occasion (April, 1905) a normal count was met with. The study of these total numbers is, however, of but little value in the absence of the differential counts.

2. Differential counts (see Table II., which deals with the percentage counts of the different varieties of leucocytes, and Table III. and Chart III. which show their total numbers).—The latter is the more instructive. The normal limits which are marked on the latter chart are, of course, only approximate, but may be taken as fair averages. The lymphocytes are considered as ranging between 1000 and 3500 per cubic millimetre, the polynuclears between 3000 and 7500. We will now consider each portion of the curve of the total leucocytes (Chart II.) in turn. (a) The initial rise, as has been noted above, is due entirely

<sup>6</sup> Ballance and Pitts: Loc. cit.<sup>7</sup> Loc. cit.



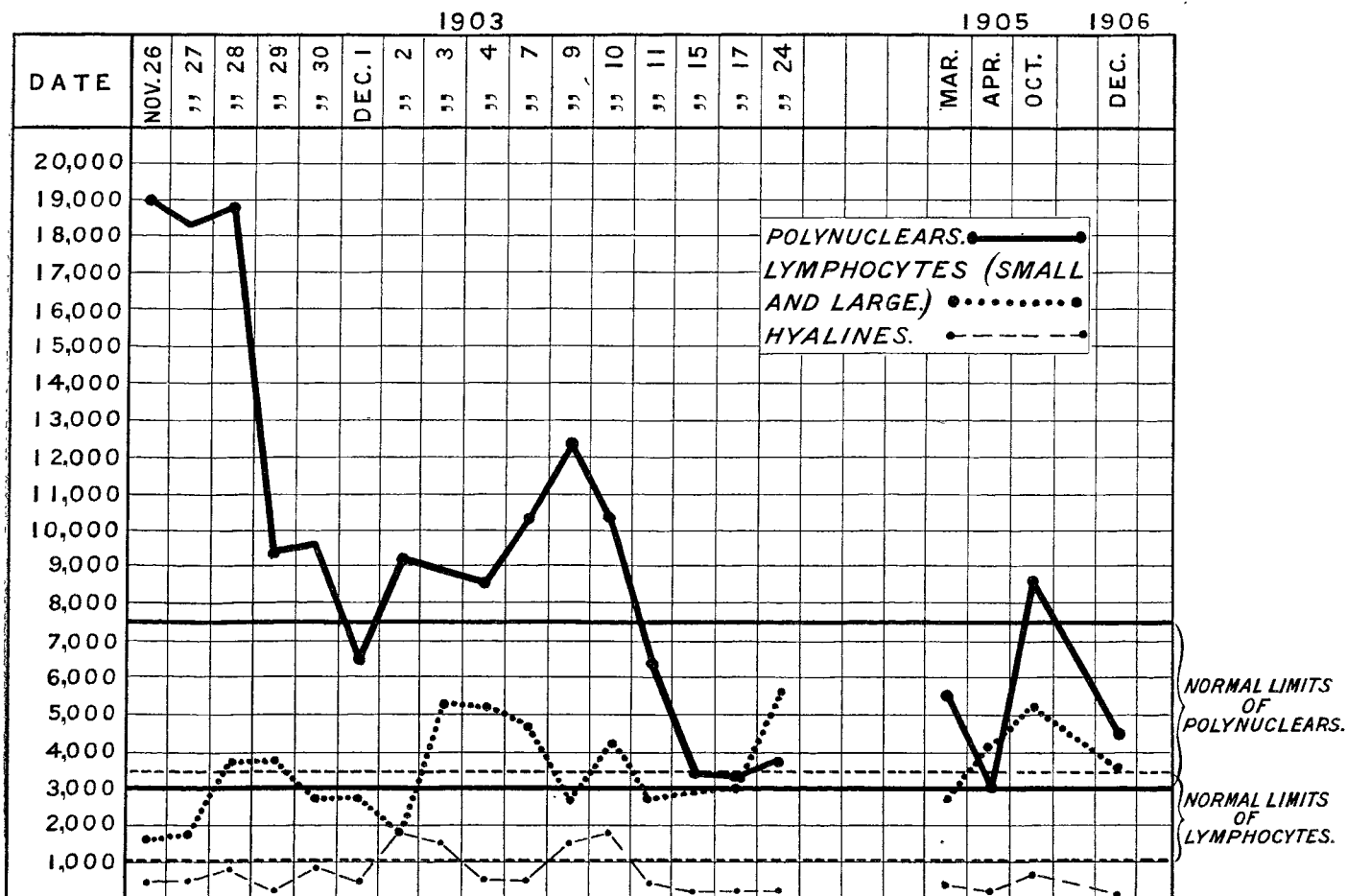
to a flood of polynuclears; the lymphocytes and hyaline corpuscles taken together formed as little as 8.75 per cent., but in spite of this the total lymphocytes did not fall below normal during this period. There were no eosinophiles at all to be found during this initial rise—a feature frequently met with in acute inflammations of whatever nature, and one which has no apparent connexion with the absence of the spleen. (b) The secondary rise, lasting from the fifth until about the tenth day, is of complex nature and is due mainly to an increase in the polynuclears, to a less extent to a lymphocytosis, and in some small degree to a reappearance of the eosinophile cells. In other words there was a mixed leucocytosis, such as is usually attributed to a stimulation of the functional activity of the whole of the blood-forming organs, especially perhaps of the bone marrow. There are several points to be noted which show beyond a doubt that there actually was a powerful stimulation of this tissue about this period. These are (1) the fact that this sudden rise of the leucocytes coincides almost exactly with the sharp rise in the red corpuscles and hæmoglobin; (2) that a few nucleated red corpuscles were present about

and persisted for two years and perhaps for more. If we compare the total numbers of leucocytes on Dec. 1st and Dec. 24th we shall find the same (10,000) in each case, but these were very differently constituted:—

	Dec. 1st.	Dec. 24th.
Total	10,000	10,000
Polynuclears, per cent.	65	38
„ total	6,500	3,800
Lymphocytes, per cent.	28	58
„ total	2,800	5,900

(c) In the counts made at an interval of more than a year after the operation we see figures quite comparable with those of Dec. 24th, with the exception that in two of the examinations there was a decided leucocytosis. In all but one of these there was a relative and absolute increase of the lymphocytes. The exception was in March, 1905, in which the lymphocytes reached 2900 (24.5 per cent.), and on this occasion there was an extraordinary number of hyaline cells (3000, or 25 per cent.) so that the exception is perhaps not a

CHART III.



Showing the total numbers of the various forms of leucocytes.

this time; and (3) that myelocytes also occurred. But it would not be justifiable to assume that the whole of the changes are attributable to the bone marrow, for it was in the early portion of this period that the lymph glands were found to be enlarged and tender. The fall which terminated this second period of leucocytosis was due almost entirely to a diminution of the number of polynuclears. This is well shown on Chart III., where the fall is seen to commence on Dec. 9th and last until Dec. 15th, the range of numbers being between 12,474 and 3710—i.e., from a figure much above the normal upper limit to one just above the normal lower limit. We may fairly assume that the stimulation of the bone marrow ceased about Dec. 9th. During the subsequent period the lymphocytes were irregular, with perhaps a slightly downward tendency, but at the last examination of the first series (Dec. 24th) we find they had undergone a decided rise, reaching 5000 or 1500 above the normal level, at this date, the polynuclears remaining at a very low normal. It is unfortunate that the counts were not carried on for a few days longer, but the after history shows that in all probability there was actually a very decided total and relative lymphocytosis which commenced at this time

real one. At the last examination, more than three years after the operation, the blood, though normal in other respects, still shows a decided increase in the lymphocytes. These cells form 43.25 per cent. of a total count of 8800 per cubic millimetre. This is equivalent to 3800 per cubic millimetre, a figure slightly but decidedly in excess of the normal. The total number of the polynuclears is normal (4700), though their percentage is necessarily reduced (54 per cent.).

We may sum up these changes as follows. There was a marked polynuclear leucocytosis which fell to normal in about six days and then showed a recrudescence for some ten days, after which these leucocytes remained within normal limits. The lymphocytes, on the other hand, began to increase in numbers some seven days after the operation, and there has been a more or less marked lymphocytosis ever since.

The eosinophiles.—We have found no results which corroborate Ehrlich with regard to there being any eosinophilia after the operation. On the first three examinations these cells were absent. On the fourth day 0.5 per cent. were present, on the fifth 0.75, on the sixth 1.25, on the seventh 2.75, and on the eighth 4 per cent. After

this the figures showed the variations usually met with in healthy persons. The normal totals are generally considered as ranging between 50 and 500 per cubic millimetre. In this patient the minimum (after the first three days) was 67 and the maximum 668; this was the only occasion on which the number 500 was exceeded, except in October, 1905, two years after the operation, when 555 were met with. We may fairly consider the counts as being quite normal in this respect and the absence of the eosinophiles during the first three days is, as has been pointed out above, not peculiar to cases of splenectomy.

*The mononuclear cells.*—We had hopes that a careful analysis of the mononuclear leucocytes, in the early period especially, might throw some light on the relations of these cells to one another and to this end we prepared a careful list of all the varieties of lymphocytes, hyaline cells, transitional cells, &c., met with. These were arranged under ten headings, the grouping being facilitated by careful micro-metric measurements where necessary. The labour expended in the preparation of this table was very great and an inspection of our results led us to the opinion that no valid conclusion could be drawn from it, so that we have stated our results on ordinary lines and have not given this extended table. We found that there was no sort of sequence in the results which we obtained in this way, a form of leucocyte which occurred in large numbers in one day being entirely absent on the next.

An inspection of Tables II. and III. will show that the lowness of the total numbers of the lymphocytes which occurred immediately after the operation was due mainly to the scarceness of the small forms, of which there were less than 900 present, whereas the large lymphocytes and hyaline cells were in normal amount. For the next four days the small lymphocytes increased, reaching 3805, four times their initial number, whereas the large lymphocytes fell to 40 and the hyalines to 70. Then the reverse process occurred and the small lymphocytes showed a general downward tendency, though usually remaining within normal limits, whilst the larger forms, the large lymphocytes and the hyalines, showed a very decided rise. For example, on Dec. 3rd the small lymphocytes were 1200, a little above the normal minimum of 1000, whilst the large lymphocytes were 4100, about five times their normal maximum, and the hyalines 1700, their normal maximum being about 400. The predominance of large forms was a marked feature of this period, a period which, we may note, though without attempting to draw any inferences therefrom, roughly coincided with that showing signs of great stimulation of the bone marrow.

We noticed one cell which is rarely, if ever, seen in normal blood in films taken about this period. This was a very large cell, attaining nearly  $20\ \mu$ , which in general appearance and staining reactions resembled large hyaline cells, but which had nuclei as contorted as those of polynuclear leucocytes. They occurred scantily and were counted as hyaline cells. They were entirely devoid of granules.

The last stage shows merely an increase of the small forms, the large lymphocytes and hyaline cells being normal (October, 1905, and December, 1906).

In our opinion it would be idle to attempt to draw any conclusions as to the site of origin of the mononuclear cells from these figures. We may, however, draw attention to the fact that in the first two counts after the injury the lymphocytes were decidedly low, though not below the lower normal limit (see Chart III.). At this period they commenced to rise and this rise was fairly parallel to the enlargement of the lymphatic glands, which was first noticed on Nov. 27th and had disappeared entirely by Dec. 7th. It is possible that this early rise is due to these glands taking on unusual activity and increasing their output of lymphocytes, the number of which is reduced owing to the absence of the spleen. It seems clear that this early rise (from 1570 on Nov. 27th to 3890 on Dec. 29th) is not due to any increased output from the bone marrow, since at this time the number of polynuclears was decreasing, suggesting that the stimulation of the tissue was diminishing. At the same time, we have seen reason to believe that what I have called the "secondary rise" in which the lymphocytes took part (from Dec. 1st to Dec. 11th, or thereabouts) was due to increased activity of the bone marrow. If any importance is to be attached to these observations they would go to prove the usually accepted view that the

lymphocytes arise from all three structures—bone marrow, lymph glands, and spleen.

[In addition to the references given throughout this article see Simpson, Transactions of the Clinical Society of London, vol. xxxix., 1906, and Harrison and Eve, Brit. Med. Jour., vol. i., 1906, p. 320.]

## A CONSIDERATION OF SOME SYMPTOMS WHICH MAY BE PRODUCED BY SEVENTH CERVICAL RIBS.

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AN accessory rib, or pair of ribs, springing from the seventh cervical vertebra, are developmental anomalies with which all are familiar, but I venture to think that the characteristic symptoms to which they sometimes give rise are by no means so widely recognised. In these circumstances it seems worth while recording 16 cases which I have been able to collect and which illustrate the condition. Though cervical ribs produce definite vascular symptoms I wish chiefly to draw attention to the result of pressure, by these accessory ribs, on the brachial plexus. The class of cases to which I am about to refer has been described before on several occasions. Lewis Jones,<sup>1</sup> so long ago as 1893 in a paper published in the St. Bartholomew's Hospital Reports of that year, recorded several instances of symmetrical atrophies affecting the hands and occurring in young people. He gave a full clinical account of these cases, and they correspond closely with my series. At that time he ascribed them to the result of a neuritis, and did not suspect a seventh cervical rib as a possible exciting cause. It was Thorburn<sup>2</sup> who really first brought prominently forward the association of hand atrophy, resulting from pressure on the brachial plexus, with a seventh cervical rib in a communication to the Royal Medical and Chirurgical Society, published in the Transactions for 1905. In his paper he gives a description of four cases which had been under his observation and treatment, in two of which subjective sensory symptoms predominated; in the other two muscular wasting and sensory loss were the chief features. More recently still Lewis Jones,<sup>3</sup> writing in the September number, 1906, of *Medical Electrolgy and Radiology*, refers again to his cases. He has been able to trace 14 of his original series of cases and has demonstrated the presence of seventh cervical ribs in ten of these.

The frequency with which cervical ribs occur is difficult to estimate but they are by no means uncommon; four or five cases have occurred within recent years in the dissecting-rooms of St. Bartholomew's Hospital. In the majority of cases (about 70 per cent.) there are bilateral ribs, though they are not as a rule equally developed on the two sides. Llewellyn Phillips,<sup>4</sup> late demonstrator of anatomy at St. Bartholomew's Hospital, in the Proceedings of the Anatomical Society for 1900, described two cases which he had fully dissected. In the first case, that of a man, besides the cervical ribs there were various slight developmental anomalies present in the bony skeleton. The cervical ribs were bilateral but not symmetrical; that on the right side was fully developed, resembling closely the first dorsal rib, and consisted of head, neck, tubercle, and body; it articulated posteriorly with the sixth and seventh cervical vertebrae and intervertebral disc, and anteriorly with a cartilage which was ossified, and which in turn articulated with a cartilage joining the manubrium sterni. The rib on the left side was shorter and narrower and reached neither the sternum nor the first dorsal rib. The upper surface of each rib was grooved by the lowest trunk of the brachial plexus, which passed over it. Both ribs were moveable within narrow limits.

The second case was that of a woman, but the ribs, though similar, were not so fully developed, that on the left side being quite rudimentary. It was only about one inch in length, yet its upper surface was also grooved by a root of the plexus; it was firmly fixed, thus differing from the other

<sup>1</sup> St. Bartholomew's Hospital Reports, 1893.

<sup>2</sup> Transactions of the Royal Medical and Chirurgical Society, 1905.

<sup>3</sup> Medical Electrolgy and Radiology.

<sup>4</sup> Proceedings of the Anatomical Society of Great Britain and Ireland, 1900.