ANASTOMOSIS OF RECURRENT LARYNGEAL TO
PHRENIC NERVES:

SOME RECOVERY OF FUNCTION.

BY

E. BROUGHTON BARNES, F.R.C.S.ED.,

SURGEON TO THE EAR AND THROAT DEPARTMENT OF THE NORTHAMPTON
GENERAL HOSPITAL,

AND

SIR CHARLES BALLANCE, K.C.M.G., M.S., F.R.C.S.,
CONSULTING SURGEON, ST. THOMAS'S HOSPITAL, LONDON.

THE following case of complete traumatic division of both recurrent laryngeal nerves was treated by anastomosis of each nerve to the phrenic nerve of the same side. Some recovery of function was, as will be seen, observed.

The patient, a woman 52 years of age, was seen by one of us in May, 1926. She was suffering from aphonia and attacks of dyspnoea. The vocal cords were completely paralysed; the patient was breathing through a very narrow chink, and there was constant stridor. The inner borders of the cords were slightly concave, tension was absent, and a slight flapping movement was observed during respiration. She was having frequent attacks of severe dyspnoea, during which she became cyanotic. She spoke in a voiceless whisper.

The history was that in October, 1925, she had been operated on in a hospital in another city for adenoma of the thyroid gland. Since that operation she had suffered from dyspnoea and cyanosis as above described. She was admitted to the Northampton General Hospital. As long as she remained quite quietly in bed on her back without attempting to speak no attack of dyspnoea occurred, but she was not able to take sufficient nourishment. The question of tracheotomy was considered, but it was determined to attempt treatment by nerve anastomosis.

First Operation.

On June 5th, 1926, a general anaesthetic was administered by Dr. J. P. Traylen of Northampton. An incision was made along the anterior border of the sterno-mastoid muscle on the right side. It was seen then that a mass of scar tissue extended from the cricoid cartilage to the sternum. The recurrent laryngeal nerve was identified in the region of the inferior cornu of the thyroid cartilage and followed downwards in the scar tissue for $1\frac{1}{4}$ inches. Beyond this point no nerve could be found. The portion of recurrent laryngeal nerve was then freed from the scar tissue and stimulated with the faradic current, but no movement of the right vocal cord was detected.

The sterno-mastoid muscle was now retracted backwards and the search for the phrenic nerve commenced. It also was embedded in scar tissue, but as the phrenic is a larger nerve than the recurrent laryngeal the difficulty of identifying it was not so great. It was then found that it was not possible to bring the end of the recurrent laryngeal nerve to the side of the phrenic so as to perform a recurrent laryngeal-phrenic end-to-side anastomosis. A search was then made in the scar tissue for the descendens noni nerve, for if this nerve could be found the phrenic nerve could be divided and the following anastomoses done: (1) Recurrent laryngeal-phrenic anastomosis end-to-end; (2) Descendens noni-phrenic anastomosis end-to-end. But the descendens noni nerve could not be followed in the mass of scar tissue, and the only piece of this nerve seen was a short portion, useless for anastomosis, extending downwards from the lower border of the hypoglossal nerve.

Thus another plan of anastomosis of necessity had to be adopted. The main trunk of the phrenic nerve was divided through not quite half its diameter, and this smaller portion of the nerve was dissected upwards free of the larger portion

for five-eighths of an inch. It was then found that it was possible to bring this portion of the phrenic nerve across the carotid sheath and unite it end-to-end to the recurrent laryngeal nerve without tension (See Fig. 1). On stimulating with the faradic current the phrenic nerve distal to the region from which a portion of the nerve had been separated in order to unite it to the recurrent laryngeal the right half of the diaphragm contracted. There was no difficulty in maintaining a sufficient airway during anaesthesia, though there was a good deal of noise during induction and some stridor for one week subsequently. After the operation the left side of the epigastrium moved much more than the right side, indicating partial or complete paralysis of the right half of the diaphragm.

Second Operation.

On July 3rd, 1926, a general anaesthetic was again given by Dr. Traylen. A similar operation was performed on the left side as had one month previously been carried out on the right side. The scar tissue was more extensive on the left side of the neck than on the right, and the operation was, if anything, more difficult. The identified portion of the recurrent laryngeal nerve was not more than 1 inch in length. The phrenic nerve was isolated and freed for some little distance. It was then drawn under the carotid sheath and a recurrent laryngeal-phrenic anastomosis effected, end-to-side, by means of a very fine suture (see Fig. 2). The tension on the incision in the phrenic caused it to gape, so a second suture was employed to close the gap.

The right half of the diaphragm still appeared to be paralysed, and the second operation paralysed the left half of the diaphragm.

Prognosis.

By July 24th there was appreciable improvement in tone of the right cord. During August and September, 1926, the patient was gaining weight at the rate of about 1 lb. a week. She had occasional slight attacks of dyspnoea until the end of July, but since then she has not had any difficulty with respiration, except that she is still "short of breath" on exertion, such as climbing stairs rapidly. There had not been any laryngeal stridor since the end of July, 1926.

In August the patient left Northampton and went to live in Newcastle. On September 18th Mr. W. F. Wilson reported "some definite movement and adduction of the right cord on attempting phonation, which is husky but distinctly audible; the left cord is motionless and apparently fixed in the mid position." At the end of September regular daily electrical stimulation, galvanic and faradic, across the larynx was begun. On November 8th Mr. Wilson reported "there was definite movement on both sides of the diaphragm, which was well domed, and showed good muscular tone. The right cord moved better than the left, which had very little action, though its arytenoid (left) showed a marked pivotal movement to the extent of crossing the mid-line and pushing the right arytenoid away therefrom."

At the end of November the patient returned to Northampton and was seen by one of us. There was then definite movement in the right cord, strong adduction, and abduction amounting to about one-quarter of the normal range. The tone in the left cord was obviously improved—in fact, good—but there was no convincing movement. The voice was a husky whisper, rather wasteful, but with definite tone. One month later the right cord had not changed. The left showed definite adduction, but no definite abduction beyond the rebound.

In January, 1927, the patient was admitted to Northampton Hospital for more frequent electrical treatment, galvanic and faradic, across the neck. She then had strong adduction in both cords, and spoke in a loud, husky whisper. The right cord had not changed since December, but there was appreciable abduction of the left. She was instructed to stop breathing in expiration as long as possible five times thrice during the day, with the object of obtaining forced inspirations.

Movement of the left cord continued to increase, and by March 3rd, 1927, the movement on the two sides was equal, about one-third abduction on each side; adduction was strong

FIG. 1.—Right side.

3, 4, 5, Anterior primary divisions of the cervical spinal nerves.
A.C., Carotid artery. V.J., Jugular vein. K, Site of anastomosis.

FIG. 2.—Left side.

and phonation fairly good, though her voice was very uncertain in quality and pitch, and changed with disconcerting suddenness. It was observed that if annoyed she spoke with a strong gruff voice, but under examination began to whisper again. On this date the patient was given a general anaesthetic and Killian's laryngoscope was used. The direct view of the cord confirmed the above findings. An attempt was then made by means of a curved and insulated electrode, which was passed into the pharynx, to cause contraction of the crico-arytenoides posticus muscles, but no abduction of the cords occurred. The only movement observed was a very vigorous adduction of the cords. The adduction movement is the stronger movement, and may have overwhelmed the weaker contractions of the abductors if this occurred.

Under deep anaesthesia a paradoxical movement of the vocal cords (inspiration adduction) was observed. This also has been seen in monkeys after this anastomosis has been done. The abductor muscles are very sensitive to deep anaesthesia. A second attempt, a month later (April 9th), to cause contraction of the abductor muscles by direct faradic stimulation was made, but the result was as before. Strong adduction of the cords was alone seen.

On May 21st, 1927, the right cord was as before, with about one-third of the normal abduction, but the left cord was obviously retrogressing; adduction was still strong, but there was no evidence of abduction beyond the rebound.

On June 8th, 1927, the right cord was as before; the left cord was almost motionless in mid position; a slight adduction movement alone remained. For the first time since she was seen in May, 1926, the patient spoke continuously in a fairly strong voice, not in a whisper, while under examination. Her general condition is continuing to improve.

Remarks.

The presence of an extensive area of scar tissue on both sides of the neck not only made the operations of great difficulty, but made us doubtful of a satisfactory result.

The patient had definite improvement in the tone of the right cord seven weeks after the operation; the inner border of the cord was straight and tense. She had no further attacks of dyspnoea. Subsequently (four months after the first operation) she had definite laryngeal tone in the voice and definite movement of the right cord.

Nine months after operation she sometimes spoke in a strong voice (we are of the opinion that there is a functional element in her aphonia) and had abduction of both vocal cords giving rather less than one-third of a normal glottis opening. Adduction was strong. Her general health was definitely improved, though still far from good.

Nearly one year after the operation the left cord could no longer be seen to abduct. We are of opinion that the condition of the right cord is permanent. It has strong adduction and crosses the mid-line, and abduction to one-third of the normal.

It may be asked, what has the patient gained by these anastomoses? The answer is that she has been saved from imminent suffocation, and can now go about the world without fear of sudden death, and that though the result is far from perfect, owing to the peculiar circumstances of the case, we think it is better than if the woman had been permanently sentenced to the wearing of a tracheotomy tube. She has also gained a fairly good voice.

The period of time required for the recovery of tone in the cord and the commencement of movement in the cord in this patient coincides with what has been observed in corresponding experiments in the monkey. In man when an end-to-side recurrent laryngeal-phrenic anastomosis is done we recommend that the nerves should be passed behind and not in front of the carotid sheath.

It is to be noted that both halves of the diaphragm recovered their complete motility. The paralysis of the diaphragm did not appear to inconvenience the patient. Part of the right half of the diaphragm was probably recovering before the second operation was done.

The splitting of the phrenic nerve on the right side appeared to us an unsatisfactory method of anastomosis, and one likely to be specially sensitive to pressure by scar tissue, but it has given a better result than the end-to-side anastomosis on the left side. On the left side, however, tension at the anastomosis could not be avoided, and tension at the site of nerve anastomosis may spoil the result of any such operation.

THE EXPERIMENTAL PREVENTION OF STONE IN THE BLADDER IN RATS.*

BY

R. McCARRISON, C.I.E., M.D., D.Sc., F.R.C.P.,

LIEUTENANT-COLONEL I.M.S.,

DIRECTOR, DEFICIENCY DISEASES INQUIRY, PASTEUR INSTITUTE, COONOR, SOUTH INDIA.

In a paper in the JOURNAL of April 16th, 1927 (p. 717), the experimental production of stone in the bladder in rats was recorded. The composition of the calculus-producing diet was:

Tinned Scotch oatmeal or <i>atta</i> *	...	...	53 parts
Linseed meal	...	...	20 "
Tinned cornflour	...	...	25 "
Sodium chloride	...	...	1 "
Calcium phosphate	...	...	1 "
Distilled water	...	...	<i>ad libitum</i>

* *Atta* is whole-wheat flour.

The present report deals with the prevention of stone in the bladder in rats fed on an "oatmeal diet" of the above composition.

THE EXPERIMENT.

Two groups of young rats, 18 in each, were selected; their aggregate body weight was the same—910 grams. There were 9 males and 9 females in each group. The body weight of the males ranged from 50 to 58 grams, of the females from 46 to 52 grams; all were of approximately the same age. The 36 animals were confined in twelve precisely similar cages; 3 males or 3 females being placed in each. All were fed on the oatmeal diet and water, and were allowed to eat as much as they liked. One group received fresh whole milk in addition to the oatmeal diet; the other did not. A ration of 2 ounces of milk was provided for the three rats in each cage, but some secured more than their share.

The experiment was continued until the death of all animals receiving the oatmeal diet without milk; the last two animals died on the 150th day. The experiment was protracted for a further seventeen days in the case of the animals receiving milk in addition to the oatmeal diet; the survivors (15) on this regimen were killed by drowning on the 167th day. All animals were subjected to *post-mortem* examination.

RESULTS.

The results of the experiment may be summarized as follows:

The animals fed on the oatmeal diet without milk grew badly; all died within periods ranging from 66 to 150 days. Nine (50 per cent.) were found at *post-mortem* examination to have stones or gravel or both in the bladder, usually with, but in one case without, cystitis. Cystitis was present in one case without associated stone or gravel. The stones ranged in weight from 2.4 to 99 mg. The sequelae of calculus (dilated ureter, hydronephrosis, and pyonephrosis) were not present in any case in this series; nor was stone found in the ureter or kidney. In one animal a large grey-white, pear-shaped, fibrinous mass was present in the bladder, the thin end being drawn out into a fine thread which extended into the urethra; this condition was associated with haematuria. Bloody urine was passed by two other animals, in one of which cystitis was present in association with a number of minute stones (gravel). The three animals in which haematuria was observed prior to death were found at *post-mortem* examination to have suffered from severe anaemia, associated with a lemon-yellow tinting of the skin and subcutaneous tissues. Three of the 18 rats in this group died of pneumonia; in 3 others no cause of death could be found except asthenia.

The animals fed on the oatmeal diet with milk grew well as a rule, though some better than others; this was no doubt due to the fact that some of them secured more of the milk ration. Two died of pneumonia, and one of an unknown cause. The other 15 remained in good health.

* This abstract is published by permission of the Director-General, Indian Medical Service. The full paper will appear in the *Indian Journal of Medical Research*.