of carious teeth, the amount and extent of each carious area, and the "degree" of hardness or softness noted.

The main results are summarized in Table III, and are compared with those obtained in the previous investigations. They indicate that a diet rich in vitamin D and calcium and devoid of cereals has greater inhibitory and curative effects on dental caries than any previously tested. Thus the new carious points observed to develop during the feeding period were only 0.05 per child as compared with the previous best result of 0.2 per child. The figure 0.05 is so small that it probably falls within the margin of error of this type of observation, and new caries may be considered, therefore, to have been suppressed. Only 0.32 teeth per child, as compared with the previous best figure of 0.8, showed an extension of the areas which were carious at the beginning of the investigation; this figure also probably comes within the margin of error. The average age of the children in the third and fourth investigations was under 6, while the average in the first and second was approximately 8 years. In order to make the figures more comparable, therefore, the results for the children of about 6 years in the first and second investigations have been grouped together in Table IV, with the results of the later investigations. The hardening of carious areas, which indicates the diminution in activity of the carious process and ultimate arrest, was one of the characteristic changes brought about by the diets used. It will be observed that the removal of cereals from the diet also increased the amount of arrest of caries as compared with that produced by the diets containing this food. The average number of teeth per child in which some hardening of active carious areas was found was 4.7, as compared with 3.9 teeth per child, the best result previously obtained. It is doubtful whether better results are attainable in hypoplastic teeth on the basis of our present knowledge.

The practicability of giving a cereal-free diet to children has, of course, to be considered. In the present investigation no difficulty was encountered in the elimination of cereals from the food, although the children did not like giving up bread. These children were in an institution, and were confined to bed, but it would obviously be more difficult to give the diet to active children, especially if living at home. The tests do not indicate that in order to prevent dental caries children must live on a cereal-free diet, but in association with the results of the other investigations on animals and children they do indicate that the amount of cereal eaten should be reduced, particularly during infancy and in the earlier years of life, and should be replaced by an increased consumption of milk, eggs, butter, potatoes, and other vegetables. They also indicate that a sufficiency of vitamin D and calcium should be given from birth, and before birth, by supplying a suitable diet to the pregnant mother. The teeth of the children would be well formed and more resistant to dental caries instead of being hypoplastic and badly calcified, as were those in this investigation.

SUMMARY

1. A group of children averaging $5\frac{1}{2}$ years of age were given a cereal-free diet rich in vitamin D and calcium for a period of six months. The teeth of the children were defective in structure (hypoplastic), and much active dental caries was present at the beginning of the investigation.

2. Initiation and spread of caries were almost eliminated by these diets, and the results were better than those of the previous investigation in which the vitamin D alone was increased in a diet containing bread and other cereals.

3. Active caries was arrested on this cereal-free diet to a greater extent than in the previous investigations, when cereals were extensively used.

We wish to express our gratitude to the Medical Research Council for making this investigation possible.

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MALIGNANT DISEASE OF THE HYPOPHARYNX AND ITS TREATMENT BY EXCISION *

BY

WILFRED TROTTER, M.S., F.R.C.S., F.R.S.

SURGEON, UNIVERSITY COLLEGE HOSPITAL

Cancer of the pharynx presents to the surgeon a problem as urgent as it is difficult. The disease is far from uncommon, and its natural course is painful, repulsive, and always fatal, so that it may well be regarded as one of the very worst affections of middle age. For the surgeon the pharynx combines three of the most formidable obstacles to the exercise of his art: it is inaccessible in a high degree, it is the seat of delicate and concentrated function, and it contains septic material to which the surrounding tissues are in no way immune.

In spite of these difficulties it can fairly be said that in the last twenty years a certain degree of progress in the attack on the problem has been made, so that a not wholly inconsiderable number of persons have enjoyed a substantial number of years of good health or are still living, all of whom without treatment would have died within a few months. Two lines of treatment have contributed to this modicum of success: first, surgical excision of the disease, and secondly, radiotherapy, usually combined with some form of surgical intervention. In this paper I shall deal solely with the method of plain excision with the knife. This will be because a single theme lends itself to easy exposition, and because my experience of this method is by far the longer and the more extensive, and not at all because I have any doubt that radiotherapy is a most valuable addition to our resources in treating cancer of the pharynx.

DEFINITIONS

The term "hypopharynx" is not always used in the same sense. I have been accustomed to denote by it the tubular or post-cricoid part of the pharynx, a segment which from the physiological and the clinical points of view deserves a distinct name. For the purposes of this discussion, however, it may be more convenient to accept the extension of the word to all the pharynx that lies below the epiglottis—that is, to the so-called laryngeal part of the pharynx. The region thus denoted has from the surgical point of view, moreover, a unitary character, in that access to the whole of it is to be got by a single operative method—the lateral transthyroid pharyngotomy.

*Introductory paper to a discussion in the Section of Laryngology, Royal Society of Medicine.

With the exception of a few rarities, malignant disease of the hypopharynx thus defined is always a squamous epithelioma, and it will be assumed throughout this paper that this is in every case the lesion.

CLINICAL TYPES OF THE DISEASE

Such progress as has been made in the attack on malignant disease of the pharynx has been contributed to by three chief factors: first, a satisfactory method of access; secondly, the control of post-operative infections; and thirdly, a knowledge of the natural history of the disease itself. As has so frequently happened in other departments of surgery, when it became possible to expose and explore the region with reasonable safety and precision fresh light at once began to appear on the behaviour of local diseases. It soon became obvious that the disease occurs in very well-defined clinical types, the exact recognition of which is of great importance in prognosis and treatment. The types can be learnt far more effectively from experience gained in actual operative exploration of the pharynx than from the most careful clinical examination. It is for this reason, perhaps, that it is still not generally recognized that to establish the precise localization of the tumour is almost as important as to establish its nature.

The value of recognizing these clinical types is, to my mind, so great that what I have to say will consist chiefly of a brief description of them; in order, however, to give them a greater concreteness it may be well to mention at least one actual case of each. Epithelioma of the hypopharynx has five common starting points in this order from above down: the ary-epiglottic fold, the pyriform sinus, the lateral wall, the posterior wall, and the post-cricoid region. Although all these points are not far removed from one another, growths originating in them differ widely in symptoms, in prognosis, and in the details of treatment.

Growths of the Ary-epiglottic Fold

These constitute one of the classical and generally recognized types of so-called extrinsic laryngeal cancer. It is favourable in that it causes early hoarseness and stridor, and lends itself in early cases to removal without serious mutilation. I may mention in illustration a hospital patient referred to me by Sir StClair Thomson.

Case 1.—Stout plethoric man, about 60, with chronic bronchitis. Typical epithelioma of ary-epiglottic fold, mass of glands in the neck on the same side so large that it had been regarded as a lipoma. Two-stage operation—glands first, then later lateral pharyngotomy and excision of primary growth. Patient recovered with no residue of the operation except some hoarseness. Seven years later he developed an epithelioma on the *opposite side* of the pharynx; the scar of the operation on the mucous membrane was still visible and quite healthy.

Growths of the Pyriform Sinus

These are extremely common and are of evil repute, not so much because they are inherently difficult to cure as because the diagnosis is not usually made at an early period. The growth, on account of its station in a recess of the pharynx, causes at first little but a slight though persistent sense of discomfort, and may escape discovery with the laryngoscope. It is not uncommon for the patient to be seen first when there is already a mass of hopelessly fixed glands. With the extension of the growth into the lumen of the pharynx symptoms become severe.

I may perhaps mention here a case where the growth was in this situation, not, however, as typical of its class, but because of the exceptional interest of the origin of the growth. The patient was referred to me by the late Sir Felix Semon.

Case 2.—The patient had been operated on some six years earlier for an epithelioma in the floor of the mouth. He now

had a rounded swelling by the side of the upper opening of the larynx and occupying the pyriform sinus. It showed a superficial ulceration. The swelling was removed by local excision. It was pronounced by the late Professor Shattock to be a squamous epithelioma possibly growing in a lymph node, and therefore, perhaps, a recurrence from the mouth. The patient recovered, with normal function, and survives without recurrence after over twenty years.*

Growths of the Lateral Wall

These constitute undoubtedly the most important type that has been revealed by operative exploration of the pharynx. Its importance resides in this, that while it is extremely amenable to treatment by excision, its exact nature is often overlooked and an unfavourable view taken of the prospects of treatment. The growth starts in the lateral wall at about the level of the apex of the arytenoid, but well away from the upper laryngeal opening. As the growth develops its anterior edge sooner or later involves the arytenoid and lateral wall of the larynx. In its earliest stages it can be removed without interference with the larynx, and the pharyngeal wall sutured completely. The growth projects inwards and overhangs the arytenoid, the vocal cord, and the upper laryngeal opening on the same side, thus often leading to a mistaken diagnosis of a primary ary-epiglottic or pyriform sinus lesion. When it is of fungating type the appearances are far more formidable than the actual state of affairs. Since there is no primary involvement of the arytenoid, the vocal cord remains movable to a late period, and this late mobility of the cord becomes of the utmost prognostic importance. Whenever, therefore, the cord remains movable, operation should always be considered, however grave the general picture may be. A special difficulty in diagnosis comes from the fact that the cord and the arytenoid are often completely hidden by the projection of the tumour.

The importance of this type seems to me so great that I may perhaps be allowed to quote several cases illustrative of it.

Case 3.—A hospital patient, admitted for severe stridor and difficulty in swallowing. Laryngoscopic examination showed the pharynx at the level of the upper opening of the larynx to be filled by a yellow, sloughy mass, which concealed the vocal cords, but seemed to be attached laterally. The tumour was removed by lateral pharyngotomy. It involved the arytenoid region, and was thought at the time to have arisen in the ary-epiglottic fold; further experience, however, makes it practically certain that this was a true lateral wall growth. The patient recovered, with good function; he was lost sight of after five years, but at that time there was no recurrence.

Case 4.—A man of 57, referred to me by Sir James Dundas - Grant. Typical lateral wall growth projecting moderately inwards, but with movable cord. An unfavourable subject, with chronic bronchitis. Local excision by transthyroid pharyngotomy. The patient recovered, with normal function, and has had no recurrence after seven years.

Case 5.—A man of 62, referred to me by Dr. George Cathcart. The patient was somewhat plethoric in type, with a tendency to chronic bronchitis. A typical right-sided lateral

Epithelioma of right lateral wall (moderately early) removed by local excision. No disability and no recurrence after seven years. (Case 4.)

* In this case the operation of lateral transthyroid pharyngotomy was used for the first time.

wall growth of large size was present. A very large mass of glands extended from the mastoid to the clavicle. This was on the whole the most formidable-looking case of pharyngeal malignant disease I have ever operated on. The glands and primary growth were dealt with at one operation. The primary growth had come through the pharynx wall and was fixed to the ala of the thyroid, which was therefore removed in continuity with it. The patient recovered, with normal function, apart from a partial fixation of the right cord. Six years after the operation he developed an epithelioma of the gum on the upper jaw, where a dental plate had caused ulceration. This responded to radiotherapy at the hands of Dr. Finzi. There has never been any sign of recurrence in the pharynx or glands up to the present time—one month short of seven years since the operation.

Case 6.—A man of 56, with a really early lateral wall growth well away from the arytenoid region. Treated by local excision, with immediate closure of the pharynx. Recovery, with normal function. The patient remains free from recurrence three and a half years after operation. The case is mentioned after the comparatively insignificant period of three and a half years only to illustrate my confidence that with this type of growth treated in this way one may regard a cure as practically certain.

Growths of the Posterior Wall

The three types we have already considered are practically confined to men. With the posterior wall we come to a region where the liability of women to carcinoma of the pharynx begins to appear, though in this type men still predominate. The growth is seated on the posterior wall with but little inclination to one side; its upper limit may be at, or a little above, the level of the tip of the epiglottis; its lower limit may extend into the post-cricoid region. Although it is sometimes visible by direct inspection through the mouth the disease is often overlooked in the early stages. The technical interest of this type lies in the fact that any excision of the posterior pharyngeal wall calls for an immediate plastic reconstitution by a skin flap.

Case 7.—A middle-aged female hospital patient. There was a large epithelioma on the posterior wall opposite the upper opening of the larynx. Palpable glands later proved not to be epitheliomatous; unilateral gland dissection, followed at once by lateral pharyngotomy. A large area of the posterior pharyngeal wall was excised with the growth and immediately replaced by a pedicled skin flap. A secondary operation a few weeks later divided the pedicle of the skin flap and closed the pharynx. The patient recovered, with normal speech and swallowing. Eight years later a rapid and extensive local recurrence took place.

Growths of the Post-cricoid Region

This type has three very remarkable peculiarities: it is a disease of women; it occurs in them at an age a good deal younger than does cancer of the pharynx in men; and it is often preceded by difficulty in swallowing of slight degree, but of many years' duration. It is a disease of symptoms, and its leading symptom is a rapidly increasing dysphagia, which may be well marked when any examination short of direct endoscopy yields no evidence. Post-cricoid carcinoma contrasts strikingly with the disease in the next common seat below it—carcinoma of the cervical oesophagus. This is a disease of men, and a disease of physical signs rather than of symptoms, for it causes no early dysphagia, and usually shows itself first by causing paralysis of a vocal cord and enlargement of the thyroid gland.

The post-cricoid carcinoma seems to vary in malignancy a great deal, and its appearance is sometimes misleading, as is shown in the following illustrative case.

Case 8.—Hospital patient, middle-aged woman of excellent physical and mental character. Typical post-cricoid carcinoma; diagnosis easily made by ordinary laryngoscopy.

Lateral transthyroid pharyngotomy. The growth was extensive, and almost encircled the pharynx. A very unfavourable opinion was formed, but the operation was carried out, a complete annular resection of the tube being done, extending from the arytenoids well into the cervical oesophagus. Immediate reconstruction by a pedicled skin flap, with separation of flap and closure of pharynx some weeks later. Patient recovered, with good function. Apart from some occasional trouble from a fibrous stricture where the reconstructed pharynx joins the oesophagus, the patient remains well and free from recurrence nine years after the operation.

OPERABILITY

The operation of local excision for cancer of the pharynx can be recommended with reasonable confidence only where the patient is edentulous, the growth is still confined within the pharyngeal wall, and gland involvement is limited, the glands being hard, well defined, and not fixed. It must be confessed that I have often defied these restrictions with impunity, and even in the illustrative cases I have mentioned there will be found two examples of very extensive gland involvement, and one example of extension through the pharynx to the thyroid cartilage. This impunity, however, merely tends to show that within the requirements I have laid down the margin of safety is good. A greater severity must, however, be insisted on with the post-cricoid carcinoma. There any gland involvement is very grave, and the other restrictions are indispensable to reasonable safety and a fair prospect of success. My experience suggests that apart from post-cricoid cases the seriousness of lymphatic gland involvement has been a good deal exaggerated.

LATE RECURRENCES

Every advance in the surgical treatment of malignant disease has revealed a liability to recurrence at periods far later than had been suspected as possible from experience with more imperfect methods. This possibility is strongly shown even in the few cases I have quoted to illustrate my theme. I have mentioned a case of direct local recurrence after eight years; a case of an epithelioma near but not at the site of the original growth after seven years; a case of an epithelioma appearing in the mouth six years after excision of one from the pharynx; and a case of an epithelioma in the pharynx six years after the excision of one in the mouth. In such a small group these four cases form a remarkable little series in that the narrow limitation of the time of reappearance of the disease to the period between six and eight years after the primary operation, applies both to true local recurrence and to apparently fresh outbreaks of the disease.

The hypothesis that seems most satisfactorily to account for these facts is as follows. The growth of a cancer arouses resistance in the body of the patient. This immunity is not strong enough, except in rare cases, to check seriously the progress of the disease, but when the cancer is, as we say, successfully removed, the relative immunity survives and can keep in check the minute doses of the tumour left behind or the tendency for fresh cancers (of the same type) to start. In time, however, this immunity gradually declines, and in the case of the pharyngeal epithelioma reaches so low a grade in about seven years that surviving relics of the original tumour can assert themselves or a fresh outbreak occur.

However we may regard such a hypothesis, it is plain that estimates of the final results of treatment based on periods of much less than seven years' freedom from recurrence can have only a limited value. This criticism must not, of course, be pressed too far, since periods of freedom much shorter than seven years, and in no sense deserving to be called cures, may, from the patient's point of view, be very well worth having.

RESULTS

The final results of operative treatment must be considered from two points of view: first, freedom from recurrence, and secondly, the condition in which the patient survives. Throughout the foregoing remarks I have tried to lay all possible emphasis on the value of precise local knowledge of the epitheliomas of the pharynx in dealing with them by operation. Such knowledge makes possible the exact orientation of any necessary operation, and so increases the prospect of cure and at the same time diminishes the need for mutilation. The view is sometimes expressed that the more extensive an excision the more likely is it to be successful; this is by no means necessarily true, for if the operation is not exactly oriented in regard to the growth its mere extent is unlikely to save it from failure. This criticism applies to many cases in which extirpation of the larynx is practised in dealing with pharyngeal growths. There are, in my opinion, very few cases in which that formidable mutilation is of use in the treatment of such growths. Most of the cases in which the tumour cannot be got away without laryngectomy are incurable by any operation, and where the tumour can be got away by local excision the mere addition of laryngectomy, in my opinion, gives no further security. It will be noticed that in the small number of illustrative cases I have mentioned, the only residual disabilities left have been the occasional fixation of one vocal cord, and in one case some fibrous constriction of the oesophagus. I should not feel able to record as a true success the cure of a pharyngeal carcinoma won at the expense of laryngectomy. One of the most beneficent effects of the introduction of radiotherapy has been its

tendency to make us look with increasingly critical eyes at treatment by crudely mutilating operations.

With regard to the small number of actual results I have quoted, it must be understood that they are intended to be illustrative of the various clinical types of disease rather than to embody a full statement of experience. Such a statement to be satisfactory would have to be much more detailed and extensive. It would include a certain number more of successful results, a good many partial successes with freedom from recurrence up to some such trivial period as three years, and a considerable number in which the operation was fatal or a failure. The cases I have actually quoted may, such as they are, be put together in a list with a statement of the length of freedom from recurrence that followed in each case on the simple excision of the growth. In this way a more general view is obtained.

Case	Free from Recurrence
1. Ary-epiglottic fold (extensive glands) ...	7 years
2. Pyriform sinus	20 "
3. Lateral wall (large primary growth) ...	5 "
4. Lateral wall (moderately early) ...	7 "
5. Lateral wall (large primary; extensive glands)	7 "
6. Lateral wall (early)	3½ "
7. Posterior wall	8 "
8. Post-cricoid (extensive)	9 "

The eight cases thus show an average freedom from recurrence of over eight years. Even a group so small as this, especially when it is remembered that none of the patients suffered any serious mutilation, does, I think, suggest that in suitable circumstances the method of plain local excision with the knife has a definite usefulness.

THE MANAGEMENT OF URINARY CALCULI*

BY

ARTHUR JACOBS, F.R.F.P.S. GLAS.

UROLOGIST, GLASGOW ROYAL INFIRMARY

The symptomatology of stone in the kidney and ureter is legion. Briefly enumerated, the characteristic symptoms are: pain, which is often agonizing, haematuria, increased frequency of urination, nausea and vomiting, and, when infection supervenes, pyuria. During an attack of colic it is impossible to say what position the stone occupies, but the more pronounced the bladder symptoms of frequency and dysuria, the more probable it is that the stone is lying in the lower segment of the ureter.¹ A stone slowly passing down the ureter is characterized by intermittent attacks of colic. As the attacks recur the point of maximum pain gradually shifts from the back to the anterior abdominal wall, and follows a course downwards along the line of the ureter. Should the stone reach the lowest limit of the ureter and partly project through the ureteric orifice into the bladder, pain is felt at the tip of the penis at the end of urination.

When a stone becomes impacted in the ureter, the acute attacks give place to a fixed pain, usually in front, at an area along the outer border of the rectus abdominis muscle. If such a pain in front is accompanied by an ache in the posterior renal area, commencing dilatation in the kidney is probably taking place as a result of back pressure. If the impaction occurs in the terminal end of the ureter immediately outside the bladder wall, symptoms referred to the genital organs may result, owing to the anatomical proximity of the ureter to the genitalia and the intimate relationship between the nerve supply of these structures. In both sexes the stone may

cause pain during or after coitus. In the male, painful nocturnal emissions and pain in the testicle or along the course of the vas may also be felt.² The following case illustrates this symptom-complex, in addition to some other interesting features.

A man, aged 55, was referred to me in January, 1930, complaining of a continuous ache on the right side of the perineum and pain along the urethra following coitus. In 1927 he had had severe attacks of colic in the upper right abdomen. In October of that year an x-ray examination had shown two small calculi in the right kidney. Three months later these were found to have travelled down the ureter to the level of the iliac crest. Four months after that no shadows were observed on further radiographic examination. The patient, however, continued to have pain, at first in the right iliac region and then in the perineum. I found, on cystoscopic examination, a marked delay in the secretion of indigo-carmin from the right kidney, and a catheter which I passed into the right ureter was obstructed 4 cm. up. A radiogram taken with the ureteric catheter in position showed that the two calculi, first seen in the right kidney some thirty months previously, had become impacted in the lower end of the ureter. They were successfully removed by cystoscopic manipulations, and the patient has been free from all symptoms since.

Sometimes a calculus may give rise to no pain or colic at all, and is only discovered on investigating the cause of a chronic pyuria or haematuria. This absence of pain is usually associated with a large renal calculus. The smaller stones tend to move about and block the outlet of the kidney pelvis. Pain from over-distension follows. A stone may, however, pass from the kidney to the vesical end of the ureter without causing pain.

In February, 1928, I cystoscoped a doctor who had had intermittent symptomless haematuria for seven days. It was thought that he was probably suffering from a bladder papilloma. The bladder was quite normal, however, but a catheter passed into the left ureteric orifice, which looked

* A lecture delivered before the Northern Medical Society, Glasgow, December, 1931.