asphyxia. If the above procedure is followed so far I do not think it then matters which cavities are first of all subjected to more detailed examination unless the case be one of poisoning, in which circumstance the abdomen would naturally come first, or unless, again, it is evident that one of the cavities is specially concerned in the causation of death. In ordinary cases my practice is to proceed with the dissection of the mouth and upper air passages, then to follow these parts downwards and to remove them *en masse* along with the contents of the thoracic cavity, thus to obtain a connected view of the whole respiratory tract and to be able to trace foreign matters, &c., down into the smaller bronchi without the risk of accidental contamination by blood which is apt to occur if the lungs are removed separately. The heart and aorta also can thus be more satisfactorily examined while the now empty thorax is visible in every part. I notice that some books on forensic medicine in describing the method of removing the skull cap still recommend the use of the chisel after sawing through the external table of bone. Such a proceeding is, of course, inexcusable and in any circumstance the use of a chisel is quite unnecessary. Lastly, in regard to the examination of the vertebral column and cord, this should always be the final object of examination, because so far as regards the cord, to remove it before the other cavities and organs had been examined might seriously affect conditions existing in the latter of great importance in arriving at a just appreciation of the cause of death, while in regard to the vertebral column, its exact condition *quâ* fracture or injury can only be made out after it has been fully exposed to view and its manipulation thereby facilitated. The examination of the spinal cord constitutes the sole exception to the general rule that all the chief cavities and organs of the body must be examined in every medico-legal post-mortem examination. This exception will be readily conceded in the majority of cases which come under investigation, but there are some circumstances in which neglect to examine the cord would undoubtedly be a grave error, as, for example, in suspected poisoning by strychnia or some of the other alkaloids, in cases of death from tetanus, or cases in which there have been prior to death symptoms of spinal irritation or inflammation.

I fear that I have very inadequately brought before you some of the considerations which the title of this paper suggests, but if it leads to a useful discussion its primary object will have been fulfilled; at any rate, perhaps we may feel that ground has been broken in regard to a question which is of great importance and which will frequently engage our attention in the future.

Edinburgh.

BILHARZIOSIS SURGICALLY CONSIDERED.

By FRANK MILTON, M.R.C.S. ENG., L.R.C.P. LOND.,

PROFESSOR OF CLINICAL SURGERY AT THE GOVERNMENT SCHOOL OF MEDICINE AND SURGEON TO KASR-EL-AINI HOSPITAL, CAIRO.

THE morbid changes occurring in the body and known by the name of bilharziosis are due to the deposition in the tissues of the eggs of the bilharzia parasite. Surgically we have only to do with these changes when they occur in places where they can be reached by the ordinary means at the disposal of the surgeon—viz., in the bladder, the urethra, the rectum, and the female genital organs.

Bilharziosis develops in two distinct ways which may, however, be combined in the same case. Thus it may cause the destruction of the mucous membrane of the part which it attacks by the formation of new fibrous tissue replacing the glandular elements of the part, this being the atrophic form; or it may cause great overgrowth of the normal elements of the part attacked with the formation of polypi and similar outgrowths, this constituting the hypertrophic form of the disease; or these two forms may be combined to bring about a variety partaking of the characteristics of the two with the formation of an enormous mass of tissue *sui generis* which may be called bilharzial tissue.

The symptoms of bilharziosis of the bladder are hæmaturia characterised by the loss of blood occurring at the end of micturition, pain and scalding at the time of the passage of the urine, and some frequency in

micturition. These all occur in the early stage of the disease and the majority of cases never get beyond this. If, however, the disease progresses owing to repeated infection of the host by new parasites it takes on more serious characters and an intractable cystitis is developed which gradually passes into septic cystitis of the worst form, with loss of function of the bladder and constant tenesmus, entailing most severe suffering on the patient. The patient is also liable at any time during the progress of the disease to acute retention of urine from blocking of the urethra by a calculus, a piece of detached bilharzial tissue, or a clot, or to excessive hæmorrhage with retention of the extravasated blood. He is also commonly the subject of stone in the bladder and he may develop carcinoma in addition to his bilharziosis. In cases where the formation of bilharzial tissue is extreme adhesions may form between the distended bladder and the anterior abdominal wall with the subsequent formation of urinary fistulæ in this part, through which the greater part or even the whole of the urine may escape. Bilharzial infiltration of the prostate and seminal vesicles does occur, but it does not seem to give rise to any very definite symptoms and need not be considered separately. Bilharziosis of the ureter is important in that it may cause obstruction to the passage of the urine and constant hydro- and pyo-nephrosis, either by narrowing of the canal in the atrophic form or by blocking of it by polypi in the hypertrophic form. Death occurs in bilharziosis of the bladder either from exhaustion from constant pain and hæmorrhage or from disorganisation of the kidneys or from septicæmia.

The diagnosis of bilharziosis of the bladder rests chiefly on the peculiar hæmorrhage and on the detection of the eggs in the urine. The treatment of bilharziosis in all its forms must be purely symptomatic, the primary cause of the disease, the parasite, being protected from attack. The stage of hæmaturia is best treated by the administration of liquid extract of male fern which has a marked effect in controlling the loss of blood. Cystitis may be treated by washing out the bladder with mild antiseptics, such as boroglyceride or quinine, astringent solutions having very little effect. In the later stage medication by the mouth by means of salol, urotropin, or methylene blue may be added to the treatment locally. Calculi, if formed, should be removed by lithotripsy, as cutting operations run a comparatively unfavourable course. In the very late stages of the disease, when there is a great accumulation of bilharzial tissue in the bladder and the patient is being exhausted by constant tenesmus and want of rest, it will be necessary to drain the bladder. The simplest way of doing this is by means of a Cock's puncture through the perineum, as it is a simple operation and avoids all unnecessary manipulation. In certain favourable cases an attempt may be made to remove at the same time the accumulated bilharzial tissue, but this must be done with the greatest care on account of the diseased state of the bladder walls which may easily be perforated. If a cleansing operation can be done it greatly shortens the subsequent duration of the case, for even in the most favourable conditions the diseased mass will have to be thrown off by sloughing before the patient recovers. Unfortunately, the prognosis in these cases is very bad, for the kidneys are, as a rule, extensively diseased and the patients are very liable to die during the process of sloughing. Acute retention complicated by hæmorrhage must also be treated by perineal drainage in order to clear the bladder and to prevent a recurrence of the bleeding.

There appears to be no satisfactory way of treating suprapubic fistulæ, for by the very nature of the disease the bladder is incapable of resuming its functions and the urine will continue to escape by the fistulæ. Bilharziosis of the prostate would seem to be benefited by simple incision and hydro- and pyo-nephrosis must be treated on general principles.

Bilharziosis of the urethra, for practical purposes, only exists as urethral urinary fistula and may be described as such. These fistulæ are of two kinds, one, the more common, arising from the pubic side, or "roof" of the urethra, and the other, the more rare, arising from the perineal side, or "floor" of the urethra. The two forms are distinct in all respects and merit a description apart. It has been suggested that both these forms arise primarily in the peri-urethral tissues and extend to the urethra secondarily, but I do not think this is so, for if it were cases would be met with in which the disease was still localised in the surrounding

tissues and the urethra was still intact, but this I have never seen and I should doubt if it ever occurs. On the other hand, cases are met with, rarely, it is true, in which the urethra alone is attacked and, more commonly, cases are seen in which the disease is in an early stage and in all of these the urethra is affected. At the same time it is a singular fact that the urethra is the only part commonly attacked by bilharzia, where the disease instead of spreading along the surface attacks the deeper parts. The course taken by the disease in "roof" fistulæ is peculiar, for at first it is directed upwards towards the limiting membrane of the corpus spongiosum on the side of the corpora cavernosa, but on reaching this it turns round the urethra and makes its way down to the skin in the perineum which it finally destroys and opens on to the surface. The amount of inflammation involved in the formation of a "roof" fistula is but small and the symptoms to which it gives rise to in its formation are by no means severe.

"Floor" fistulæ from their earliest stages take on the form of peri-urethral abscesses, probably because, being in a dependent position, they tend to retain the urine and their own debris which decompose and excite a septic inflammation; at the same time during their formation they cause the formation of a great deal of new fibrous tissue round themselves and they also discharge a large amount of intensely irritating pus which causes secondary inflammatory changes in the distal urethra. The origin of all "roof" fistulæ is practically limited to the part of the urethra immediately in front of the bulb, whereas the "floor" fistulæ are by no means so limited. The "floor" fistulæ develop much more slowly than the "roof" fistulæ and owing to their septic nature their symptoms are much more severe. In "roof" fistulæ the history given by the patient begins with the formation of a small subcutaneous abscess to which he does not attach much importance and which he says burst and left a wound from which after a time he noticed that urine passed on micturition; in "floor" fistulæ, on the other hand, the patient complains of great pain and scalding on micturition, with difficulty and increased frequency, and if, as is often the case, he seeks advice early in the disease of a painful spot in the course of the urethra.

The signs of the two forms are also quite distinct. In "roof" fistulæ there will be one or more openings in the perineum, situated somewhat away from the immediate course of the urethra, the skin around which will be scarred and drawn into the central point but not greatly infiltrated, and there will be some thickening in the underlying tissues. In "floor" fistulæ the signs are more marked, the openings will be in the immediate line of the urethra, either in the perineum or in the penis, there will be extensive implication of the skin and the underlying structures will be infiltrated by a mass of stony hardness extending down to the urethra, there will probably be a plentiful discharge of pus from the urethra and the meatus will be scarred and markedly narrowed, and on passing a sound there will probably be found a bad stricture extending from the meatus to the point of origin of the fistula.

The treatment of both forms of fistulæ is by free excision but the method of operating differs in the two forms. In "roof" fistulæ an elliptical incision is to be made in the perineum including all the fistulæ present and the surrounding skin, and this is to be carried down to the level of the urethra, which is to be defined by the passage of a full-sized catheter; when this is reached the mass of tissue included in the incision is to be removed, by which means the fistulæ will be cut through at the point where they curve round the urethra to reach the "roof"; the remaining part of the track must then be thoroughly scraped with a sharp spoon until every particle of granulation tissue has been removed and the opening in the urethra defined; the wound should be plugged wide open with some antiseptic gauze and left to close by granulation. It is rare to find strictures in "roof" fistulæ, but they do occur in old cases with great destruction of tissue; they are then most intractable, for either they consist of dense fibrous tissue replacing the part lost or else they consist of granulation tissue the organisation of which is so low that although a catheter may be driven through it no canal will remain on the withdrawal of the instrument. When these strictures are met with the only thing to do is to excise them and to try to maintain a channel for the passage of the urine during healing.

In "floor" fistulæ the method of operating has to be different, because in them stricture is the rule and prevents

the passage of a sound and because the tissues are so infiltrated that even with a sound in position it is impossible to locate the position of the urethra at the time of operating. In these cases it is necessary to locate the urethra by cutting directly down on it and laying it freely open; when once this has been done the infiltrated tissue can be dissected away from the urethra without any fear of accidentally injuring it. The incision into the urethra not only protects it from injury, but it also acts as an external urethrotomy and assists in the cure of the stricture. The rest of the stricture should, of course, be dilated at the time of operation and the dilatation subsequently be kept up by the frequent passage of sounds.

The most intractable of all fistulæ are certain "roof" fistulæ which go astray, as it were, and instead of coming to the surface in the perineum, make their way along the division between the spongy and cavernous bodies and find an exit at the pubes or in the anterior part of the scrotum. No partial operations are of any good in these cases—the only thing to do is to lay the whole track widely open by slitting the scrotum in two halves and then leaving the wound to granulate.

In a few cases bilharziosis is limited to the termination of the urethra and the glans penis and causes the formation of an intractable ulcer at the meatus or multiple minute fistulæ in the glans. In these cases also free excision must be done and the diseased part removed, care being taken in the after treatment to prevent stricture at the meatus. The diagnosis of most forms of urethral bilharziosis is easy; with straightforward cases there can be no difficulty, as practically all urinary fistulæ in this country are due to bilharziosis. In some early cases of "floor" fistulæ in the stage of peri-ureteral abscess there may be difficulty in diagnosing the disease from impacted stone in the urethra with incomplete occlusion of the canal, but the history, the typical pus escaping from the meatus, and the passage of a sound, will clear up the case. Bilharziosis of the meatus and glans is, I am afraid, often taken for gonorrhœa, but the pus is quite different in character and the presence of the typical ulcer or of the equally typical fistulæ should make the diagnosis easy when once the existence of the disease is recognised.

In the rectum particularly good examples of the atrophic and hypertrophic forms of the disease are found. The atrophic form is developed best in the neighbourhood of the anus where the mucous membrane will be found to be replaced over large areas by the peculiar form of scar tissue, forming patches of a pyramidal shape and raised above the level of the surrounding bowel, of a grey colour paling to white in the thicker parts and with their surfaces pencilled with fine creases and fissures and with isolated patches of the same nature in the neighbourhood. In the hypertrophic cases there is great thickening of the whole of the mucous membrane with the formation of enormous numbers of branching polypi extending up the bowel beyond the reach of the finger. The earliest symptoms of rectal bilharziosis are a constant desire to go to stool owing to the irritation of the part and the excessive secretion of mucus and tenesmus from constant efforts at expelling the offending matter. As the disease advances the necessity of evacuating the bowel becomes more frequent and urgent and the straining causes the hyperæmic mucous membrane to bleed, inducing the so-called bilharzia dysentery. This is followed after a time by the stage of prolapse, when the lower bowel, as a result of constant straining, is protruded from the body, the protrusion being assisted by the heavy engorged state of the gut. In the atrophic form the disease does not, as a rule, go on to prolapse, but the straining and tenesmus are very marked. True stricture of the rectum is rare but there is a sort of false stricture due to loss of resilience and dilatibility of the part which causes the patients much suffering. Bilharziosis of the rectum kills in much the same way as bilharziosis of the bladder—by exhaustion from want of rest, constant pain, and the continual loss of blood.

The treatment of bilharziosis of the rectum in the early stages consists in allaying the irritability of the bowel by local sedative and astringent applications, such as enemata of starch and opium or of solutions of sulphate of copper or of nitrate of silver. When polypi are formed an attempt may be made to remove them, but this is very unsatisfactory, as they extend so high up the bowel that it is impossible to get beyond them and to do anything like a radical cure; still a certain amount of relief may be given which is also

increased by the stretching of the sphincters which is necessarily done at the same time. It will also be found that where the polypi are too numerous for removal swabbing out the rectum as high as can be reached with a solution of 1 in 40 chloride of zinc will cause an abatement of the more urgent symptoms. The question of excision of the rectum naturally arises in this connexion and in some few cases it may be done with advantage, but this only in cases where the prolapse has occurred in men in fair general health, who have not been broken by suffering and where the prolapse is, as it were, traumatic in its nature. In performing excision of the rectum for this disease there is no necessity for removing the sphincters and they should be carefully preserved in order to obtain a good result. Bilharziosis of the rectum has only to be diagnosed from dysentery and the onset of the disease, together with the nature of the stools and the absence of general gastro-intestinal disturbance, is quite sufficient to distinguish between them.

In females the place of the rectum and urethra, in liability to attack by bilharzia, seems to be taken by the genital organs and especially by the vulva and vagina. In the vulva any of the structures may be attacked, but the most common seat is in the labia minora. Here the disease generally takes on the hypertrophic form, with occasionally the formation of warty masses which resemble bunches of currants and which may attain considerable size. In the vagina both forms are found, the hypertrophic form occurring at the outlet and vault and the atrophic form in the canal of the vagina itself. The symptoms of bilharziosis of the vulva and vagina are not well marked; they consist for the most part of discomfort and inconvenience from the presence of the tumours and from the accompanying discharge. Bilharziosis of the uterus takes the form of polypi growing from the vaginal aspect of the cervix and I have never seen a case where it did not occur in association with bilharziosis of the vagina.

The treatment of bilharziosis of the female genitalia is by excision, which, except in cases of generally diffused bilharziosis of the vagina, is easy in execution and appears to give good results. At first some difficulty may arise in diagnosing between advanced bilharziosis of the vaginal vault and carcinoma of the cervix uteri, for the fleshy polypi closely surrounding the cervix, and shutting it in, resemble very closely the typical cauliflower growth of cervical carcinoma, but the absence of ulceration and foul discharge and of invasion of surrounding parts serves to put the surgeon on his guard, and a more careful examination will reveal the healthy cervix hidden behind the mass of new growth. In general bilharziosis combinations of any or of all of the above forms may occur, together, it may be, with other forms which are as yet beyond the reach of the surgeon, such as bilharziosis of the liver, spleen, kidneys, and probably other organs.

STATISTICS.

The few statistics which I have been able to collect are worked out from the patients treated at the Kas-el-Aini Hospital during the year 1901. These in all numbered 930, but of this number 714 attended in the out-patient department only and about these very little information can be recorded. The chief deductions which I have been able to make are as follows:—

1. *Age*.—All ages are liable to be attacked, the records showing three cases of children aged four years with bilharziosis of the bladder and 19 patients aged over 60 years. By far the largest number, however—viz., 687, or 75 per cent. of the total—were between the ages of 15 and 45 years. The total numbers were: up to five years 10, or 1 per cent.; from five to 15 years 87, or 9.3 per cent.; from 15 to 30 years 432, or 46.5 per cent.; from 30 to 45 years 255, or 27.4 per cent.; from 45 to 60 years 122, or 13.1 per cent.; and over 60 years 26, or 2.5 per cent.

2. *Sex*.—The vast majority of cases occurred among males, the totals being males 893 and females 37, or more than 24 males for every female. Part of this apparent excess is due, no doubt, to the females not coming so freely to the hospital for treatment as do the males, but it cannot be entirely due to this, for a very fair number of women come to the gynaecological out-patient department for treatment. Among children under 15 years of age the proportion of males to females is certainly a good deal less, the numbers being males 90 and females eight, or a ratio of about 11 to 1. Up to this age the sex variant is practically non-existent, but at the same time any difference in the mode of life or in

occupation which may occur among adults has not yet developed.

3. *Race*.—As regards race a very marked difference is found. Of the 925 patients under consideration, leaving out five cases of foreign or mixed nationality (a half-breed, a Jew, a Greek, an Armenian, and a Tunisian), no less than 908, or nearly 98 per cent., were Egyptians, the remainder being made up of six Berberines, six Copts, and only five Soudanese. The small number of Copts and Berberines may be accounted for by these being essentially indoor or town races, but the markedly small number of Soudanese patients can hardly be thus accounted for; it must be remembered that a large number of these blacks have passed the greater part of their lives in Egypt and under the same conditions as the native Egyptians. At present I am altogether unable to account for this apparent immunity of the dark races, but I think that it is probable that as our knowledge of the disease increases some reason for it will be found either in their habits or in their diet.

4. *Occupation*.—The statistics of occupation point very strongly to one particular class as being peculiarly liable to infection, this class being the *fellahin*, or peasant class, for out of 199 male patients whose occupation was known no less than 140, or 70 per cent., were returned as belonging to this class. In only one other class did the numbers touch double figures, and this was the class of *fiki*, or slightly educated persons of the peasant class who are attached to mosques and who also give instruction in the country elementary schools, and of these there were but 13.

5. *Geographical distribution*.—The great majority of the cases, as has been seen, come from the country, the numbers coming from the towns being very small indeed. Thus although the hospital from which these observations are taken is situated in Cairo and would naturally draw the majority of its patients from its immediate neighbourhood, yet out of 208 cases localised only 37, or about 17 per cent., are noted as coming from Cairo, and this including Old Cairo, Shubra, &c., which are practically country districts. Of the cases coming from the provinces the great majority came from the Delta. Of the 170 cases no less than 145 came from Lower Egypt and these were distributed as follows: Gharbieh, 20; Sharkieh, 39; Dakhlieh, 20; Galioubieh, 19; and Menoufieh, 38. Only 25 cases were left for the whole of the rest of Egypt and these were distributed as follows: Ghizeh (which physically is more akin to Lower than to Upper Egypt), 14; Beni Souef, two; El Fayoum, five; and Minieh, four; the provinces of Assiout, Ghirgeh, Keneh, and Assouan not sending a single case.

6. *Forms of the disease*.—The most common form of the disease as seen at the hospital is bilharziosis of the bladder, of which there were 599 cases, or 64 per cent. of the whole number treated; the next most frequent form was what is almost the same form of the disease—viz., vesical calculus, of which there were 134 cases; after this urinary fistulae, 113 cases; and then bilharziosis of the rectum and general bilharziosis, 53 cases; besides these there were 29 cases in which necropsies were made for other diseases and in which bilharzia worms were found in the portal vein.

These statistics relate to the year 1901 and they show only one case of bilharziosis of the vagina, but it is probable that other cases occurred which were not recognised. An unclassified case was one of old-standing sinuses over the sacrum in which the sinuses were found to be lined with unhealthy granulation tissue containing innumerable bilharzia eggs.

I have throughout these observations included vesical calculi as one of the manifestations of bilharziosis, but I am not quite sure that I have been right in doing so in all cases. In a large number of cases of stone there is demonstrably also bilharzial cystitis, and this not only in cases of phosphatic calculi, with decomposition of the urine, but also in cases of uric acid and oxalate calculi. Still, the connexion which I do not doubt exists between the two diseases has yet to be worked out properly. The general statistics of bilharziosis as shown in this paper would not be greatly altered if the calculi were left out, as in the matter of age, sex, race, occupation, and geographical distribution the separate figures run altogether parallel, which also might be urged as an indication of the relation of the two diseases to one another.

I had hoped to make some experiments with the urine of a number of healthy persons in order to estimate the frequency of the disease among the natives, which there is reason to believe is very great, but unfortunately I have not

been able to carry this out. Mr. W. Bryce Orme, principal medical officer of Port Said Hospital, most kindly examined the urine of 40 healthy pupils in the Government school in that town and found bilharzia eggs in five cases. Port Said, however, is not a good bilharzia centre owing to its situation and water-supply and I believe that the schoolboys of Cairo would show a much larger proportion than this. Dr. Calamawy of Assiout Hospital also examined 32 pupils of the school there, but he failed to find eggs in any of them, but then again Assiout is also not a good bilharzia centre, none of the 200 odd cases in Kasr-el-Aini Hospital having come from that province.

In order to make good this deficiency Mr. Guirgis, house physician to Kasr-el-Aini Hospital, examined the urine of 100 consecutive patients admitted to the medical side of the hospital in June of last year. Of these 100 cases no less than 35 were found to have bilharzia eggs in their urine, although only two complained of any symptom of the disease. In no less than 15 of these 35 cases was the disease associated with pellagra and this out of a total of 25 pellagra cases only; in two cases the eggs were associated with ankylostoma, and in six cases the patients were peasants who were admitted for inoculation after being bitten by dogs. The nationality of the cases admitted was as follows:—

Egyptians	...	...	...	89	with 35 cases of bilharziosis
Soudanese	...	...	...	7	" 0 " "
Berberines	...	...	...	2	" 0 " "
Others	...	...	...	2	" 0 " "

This illustrates the frequency of the disease among Egyptian peasants and the comparative immunity of the black races.

If it is permissible to draw conclusions from such a small number of cases as are here reviewed these would be as follows. Bilharziosis is a disease of very frequent occurrence in Egypt; it is most commonly found among the peasants and more especially among the peasants of Lower Egypt; it is liable to attack all ages with the probable exception of nursing children; males are more frequently attacked than females; the black races appear to enjoy a certain amount of immunity; and many more people suffer from the disease than are aware of the fact.

Cairo.

FURTHER NOTE ON THE PULSE WAVE IN AORTIC REGURGITATION.

BY PAUL M. CHAPMAN, M.D., F.R.C.P. LOND.,
PHYSICIAN TO THE HEREFORDSHIRE GENERAL HOSPITAL.

In a previous note on the heart-index interval¹ I discussed the extreme views held by various writers as to the shortening or lengthening of the interval in aortic regurgitation. I then furnished definite experimental proof that both those writers who stated that the heart-radial interval was always shorter than normal—e.g., Keyt—and those who stated that the interval was always longer—e.g., Sir William H. Broadbent—were equally inaccurate. Sir William Broadbent² having said that “the pulse in aortic regurgitation is always retarded or delayed,” I expressed myself as being in disagreement with him and in agreement with Dr. Walshe³ who confined himself to the more accurate statement that “the retardation (of the pulse) may with care be detected in many, but unquestionably not in all, cases of that disease.” When everyone cannot speak with equal authority as a clinician and when many clinicians of equal authority differ on a point of observation it is a relief to turn to actual physiological experiment for some undeniable facts. So I do not propose to discuss the matter again at any length.

1. The normal heart-radial delay is about 0.18". 2. The normal heart-index delay is about 0.20". In my former note (of a case of simple aortic regurgitation) the delay (2) was 0.216". A lengthening of $\frac{1}{100}$ " quite indistinguishable by touch.

¹ Brit. Med. Jour., Feb. 16th, 1901.

² Heart Disease, 1897.

³ Practical Treatise on Diseases of the Heart and Great Vessels, American edition, 1862, p. 72.

I now publish the following tracings from the case of a young man suffering from well-marked aortic regurgitation. The first tracing is a simple cardiogram of unimpeachable accuracy (see Fig. 1). The second is

FIG. 1.

A, Beginning of auricular systole. B, Beginning of ventricular systole and cessation of auricular systole. C, Cessation of ventricular systole. Pulse-rate, 80. Duration of ventricular systole, from 0.330" to 0.325". Duration of auricular systole, 0.083". From B to bottom of dicrotic notch, 0.175".

a simultaneous pulse and heart tracing (see Fig. 2). The three letters in this figure, P, T, and C, simply indicate pulse, time, and heart. The straight vertical lines measure off abscissæ of time in quarter seconds. The curved ordinates are described by movements of two levers, attached to the pulse and apex beat respectively by suitable connexions. In a long series of measurements, of which this is only a specimen, the heart-index delay is 0.182" usually, only in some few instances reaching a maximum of 0.200". The heart muscle in this case is largely hypertrophied and the duration of ventricular systole is at its extreme maximum for a pulse-rate of 80. It is usually less in health, varying in different circumstances between 0.30" and 0.33". It is to be noticed that the duration of ventricular systole, strangely independent of extraneous circumstances, is some evidence of structural change in the heart muscle. If very short it is direct evidence of degenerated muscle and is a means of differentiating between (1) fatty infiltration or deposit and (2) fatty degeneration of the muscular fibre itself. In the hypertrophied compensatory heart of aortic regurgitation the duration of systole is rather longer than in a normal heart; the larger muscular mass responds more slowly to stimulus, moves more slowly, and against a much larger initial pressure. The heart-index delay in this case is seen to be never longer than normal, while it is usually less than normal. It varies inversely with

FIG. 2.

Simultaneous pulse (P), heart (C), and chronographic (T) tracings. Heart-index delay, 0.182" (occasionally it was 0.200").

the vigour of the heart's contractions and the tension in the arteries. When (in other cases than this) the delay is longer than in health it is owing to a “collapsed and empty state of the arteries between the beats and partly to their large size and loss of tone,” as Sir William Broadbent³ says. But to this must be added want of due compensation arising from a heart which has not yet responded, or will never respond, to the new calls made upon it or which, having long borne

³ Loc. cit.