Lesions of the anterior part of the frontal lobe can cause disturbances of micturition, and more rarely, of defaecation. It is already known that lesions of the paracentral lobule can cause retention of urine and faeces, and the paracentral lobule is in fact a part of the frontal lobe. But the lesions which I will talk to you about are situated in the anterior half of the frontal lobe. To illustrate this subject, I will talk to you about four groups of cases; they are cases of intracranial tumours, of aneurysms, of brain wounds, and of leucotomies. I will start with a case of an intracranial tumour.

This was a 57 year old man who was sent up to hospital as a case of epilepsy of late onset. He had become increasingly sleepy and rather bad-tempered over the previous few months. His wife said that during the previous year he had changed from being a pleasant man to a nasty man. He had become more irritable and at the same time he took life less seriously. He had started making silly mistakes in his work as an accountant; and he himself had noticed that his mental processes had begun slowing up.

When he was questioned, he told me that for several months, as soon as he felt the need to micturate, he would have to rush. In fact, he would actually have to run; for he was quite unable to stop urine passing once the urge to micturate became severe. Over the same period he had become constipated.

His wife told me that when they went out, she would have to plan their journey to pass near lavatories, so that he could go to them during their walk.

The history and the lack of physical signs, except for diminished movement of the left side of his face and diminished left abdominal reflexes suggested a frontal tumour, probably on the right side. Radiological examination showed a large right frontal parasagittal meningioma, situated mainly in front of the coronal suture. Mr. McKissock operated and removed the entire tumour.

Three days after the operation, the patient told me that he was afraid to go to sleep, as when asleep, he wet the bed. He was also being incontinent of urine when awake.
By 5 days after the removal of the tumour, he said he could now hold his urine for about an hour from the time when first felt any need to micturate. From this time he was never incontinent of urine again. On the twelfth day after the operation I carried out a cystometrogram. The final stage of the actual record is shown as Fig. 1. The bladder has a small capacity. With only 150-200 ml of fluid in the bladder, there was a sudden urgent desire to micturate and a strong detrusor contraction. In the normal, detrusor contractions raising the pressure as high as this do not occur till the bladder contains 500 ml or more, and in many people they do not occur at all, unless the subject tries to micturate. This patient was on this occasion able to inhibit the detrusor contraction; and also to make the detrusor muscle relax again once the contraction had occurred. The patient had no feeling giving rise to the desire to micturate; this is the sensation for which impulses run in the pelvic nerves and then in the spinothalamic tract. And he had no sensation that micturition was imminent; this is the sensation for which impulses run in the posterior columns. And so, when micturition occurred, the patient was taken completely by surprise. Had he been examined earlier, before he had become continent again, he would not have been able to inhibit the detrusor contraction nor stop micturition actually occurring.

When the patient returned home, his constipation cleared up. His bladder control had become normal; he could sit through a cinema lasting 3 hours or so without having to empty his bladder. He had no more fits.

Altogether I have collected 10 cases of tumours showing a similar clinical picture. The tumours were all situated in the same region of the frontal lobe. In 8 of the 10, the tumour was unilateral. In 3, the tumour was too large to be of any localising value. In the others, it was situated in the anterior half of the lobe, near the midline; it affected the superior and medial part of the lobe.

There are two patients with intracranial aneurysms. The first patient was a 62 year old woman, admitted to hospital on account of a subarachnoid haemor-
rhage. She had suddenly got a severe headache, had vomited several times, and had then become drowsy. A lumbar puncture revealed deeply bloodstained fluid. Five days after the onset the patient was alert mentally although somewhat confused and disorientated. Both plantar responses were of the Babinski type, and there was very slight weakness of the left side of the face and of the left limbs. She was incontinent of urine. She said that she did not know when she was about to pass urine nor did she feel herself actually doing it.

A cystometrogram performed at this time is illustrated in Fig. 2. When 100 ml of fluid had been slowly dripped into the bladder, there was a detrusor contraction, raising the pressure to 100 cm and causing the fluid to flow down the urethra alongside the catheter. She was unaware of any sensation of impending micturition and had no sensation associated with this detrusor contraction. She was unable to inhibit the contraction, when asked to do so.

Bilateral angiography through the carotid showed an aneurysm on the left anterior cerebral artery; it is illustrated as Fig. 3. At operation the aneurysm was seen to be arising from the left pericallosal artery at the point of origin of the left callosomarginal artery. The neck of the aneurysm was tied and a haematoma of 8 ml of altered blood was sucked out from the region of the cingulate gyrus.

At first, after the operation the patient was all the time incontinent of urine; but at this time she was mildly confused. By 4 weeks after the operation, she was more normal mentally. She was then continent of urine when awake, but incontinent when asleep. A cystometrogram performed at this time, illustrated in Fig. 4, shows that when 100 ml of fluid had been dripped into the bladder, there was a detrusor contraction raising the pressure to 40 cm. The patient could feel this and could inhibit it on command. But after 300 ml had been put in the bladder, the patient could not inhibit the detrusor contraction. The functional
Fig. 3. Radiogram to show aneurysm of same patient.

Fig. 4. Drawn cystometrogram of same patient, four weeks after tying of neck of aneurysm and evacuation of clot.

capacity of the bladder had increased, the detrusor contractions were now accompanied by sensation, and they could be inhibited to some extent.

Two years later, the patient was still incontinent of urine when asleep and was occasionally incontinent in the daytime. She said she had little warning of when her bladder was about to empty, and when she drank much fluid, she never dared stray far from a lavatory. She had once had diarrhoea and then she had been incontinent of faeces. She was much upset by these symptoms.

Of the four cases of brain wounds, I will present one typical example.

This patient suffered a trans-frontal brain wound during the war in Italy. A debridement was carried out of the tracks in both frontal lobes. Three days after this operation, there were no abnormal signs in the nervous system, except for a minimal weakness of the right limbs. An air encephalogram showed a very slight dilatation of the left frontal horn. The patient’s only complaint was that
he was sometimes incontinent of urine. I first saw the patient at the base in Naples, six weeks after the injury. He was incontinent of urine whenever he was asleep and he had urgency of micturition when awake. He said he had about 2 minuts' warning; then he had no choice but to pass urine. He then had a further operation for repair of the frontal skull defect and removal of more bone fragments; there was a large single bone fragment situated just in front of the coronal suture. Following this operation he was incontinent of urine and of faeces; there was no change in his mental state, which was normal. He said he did not know when he wanted to defaecate; he would just find that he had done so; he did not even feel faeces passing. The difficulty in controlling micturition was less severe; it now consisted of extreme urgency of micturition; this was so bad that when he needed to micturate he never got time to get a urinal in position. It improved somewhat within 10 days. He could then resist the call to micturate for at most 1 to 2 minutes. He said he was passing urine abnormally frequently. He was incontinent of faeces when asleep. The location of the tract through the skull, the cystometrogram, and the amount of urine passed on several occasions are shown in Fig. 5.

<table>
<thead>
<tr>
<th>Time</th>
<th>Intake of fluid in ml.</th>
<th>Amount of urine passed per micturition in ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.15</td>
<td>450 (tea)</td>
<td>100</td>
</tr>
<tr>
<td>13.30</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>13.45</td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>15.45</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>16.00</td>
<td></td>
<td>350 (soup)</td>
</tr>
<tr>
<td>17.10</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>18.00</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>18.20</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>22.00</td>
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<td>100</td>
</tr>
<tr>
<td>06.45</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>07.00</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>08.15</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>09.50</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>12.15</td>
<td>400 (water)</td>
<td>200</td>
</tr>
<tr>
<td>13.50</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>15.30</td>
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<td>18.00</td>
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<td>250</td>
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<tr>
<td>18.40</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>05.30</td>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>

Fig. 5. Patient with transfrontal wound. Drawn cystometrogram, and chart showing amount of urine passed on each occasion when patient felt an urgent desire to micturate.
I was able to follow up this patient in November, 1950, 6 years after he had been wounded. He was still suffering from nocturnal enuresis about once a fortnight, and when awake he might be incontinent of urine if he were not near a lavatory when he got the urge to micturate.

I have 4 cases in this group. All 4 were incontinent of urine when asleep, and 3 were also incontinent of faeces. All showed extreme urgency and frequency of micturition, which was associated with an inability to hold much urine in the bladder; they all emptied their bladders with 100 to 150 ml of urine in them.

This same syndrome occurs following prefrontal leucotomy. It is often thought that the disturbances of micturition that may occur after these operations are due to the state of indifference and inertia of the patient. Although there are many patients who are indifferent to their continence, the syndrome I am describing is not a mental incontinence.

I have two group of leucotomies: The first group consists of 10 patients who had a modified version of the Lyerly-Poppen operation. In this operation, the instrument is inserted at the vertex of the skull, just in front of the coronal suture. An attempt is made to cut through the white matter between the lateral ventricle and the midline, in this plane. All these patients were incontinent of urine; they had no warning that micturition was about to occur; they would merely find themselves passing urine. This cleared up after 2 weeks. None of these patients were incontinent of faeces. On cystometrographic examination they were incontinent of faeces. On cystometrographic examination they were found to have a decreased bladder capacity owing to the micturition reflex occurring very early with only a small amount of urine in the bladder, an inability to stop detrusor contractions, with resulting incontinence.

The other group consists of 65 patients, seen at the National Hospital for Nervous Diseases in London, who had had various forms of leucotomy. I will tell you about one typical case. Immediately after a bilateral prefrontal leucotomy operation, the patient was completely incontinent of urine; this lasted about 2 weeks. She was then left with such urgency of micturition that she could not get from her bed to the lavatory in time. I first saw the patient 3½ years after the operation. Like the patient with the intracranial tumour whom I told you about, she also had to plan all her walks to pass near lavatories. She was most upset by her condition, and was so embarrassed by it that she had never mentioned it to anyone. Usually she got a normal feeling that she needed to micturate, but if her attention were much occupied, she might find that she was passing urine before she realized that she needed to. If she felt the need to micturate she could hold urine for about 1 minute before having to pass it. She found that once urine started passing she could not stop it. She was also incontinent when asleep. She had similar symptomatology with regard to defaecation, though to a less degree.
When a cystometrograph was performed, she found it most difficult to stop the micturition reflex occurring. However, she could reduce the pressure, during a detrusor contraction.

Of the 65 patients in this group who had various sorts of leucotomy, 10 had a similar clinical syndrome to the patient just mentioned. Of these 10, the leucotomy was unilateral in 1, bilateral in the other 9.

What were the kinds of leucotomy that caused the syndrome, and what kinds of leucotomy never caused it? It was never caused by the rostral type of leucotomy, and never by the orbital undercutting type of operation. It occurs only with the full standard leucotomy. Although, in the majority of these operations, it does not occur. It is true that following this operation, the patient may be indifferent to such things as continence. But the group I am talking about is of patients who have disturbances of micturition and defaecation and are not indifferent; they are much distressed and embarrassed at their lack of control.

Fig. 6. Diagram of cortex, according to von Bonin. The region involved by the lesions of the frontal lobe lie in the dysgranular area, between the agranular motor cortex posteriorly and the homotypical isocortex anteriorly.
Now let us try and localise the lesion giving rise to this disorder.

The lesion is in the superior and medical part of the anterior half of either frontal lobe. The lesion is anterior to area FB, posterior to FD; it overlaps FC and FD. This is the region, in von Bonin's division of the cortical areas, of dysgranular cortex; it lies between the agranular cortex, which is the true motor cortex, and the mass of the cortex, the homotypical isocortex. This region is illustrated in Fig. 6.

The two cases of aneurysm do not, however, fit in well with this location. One case had the lesion involving the anterior end of the cingulate gyrus and the superior frontal gyrus. And the second case, the one I told you about, the aneurysm involved the anterior end of the cingulate gyrus. However, aneurysms must cause more damage to cerebral tissue than merely the region affected by the aneurysm itself.

The modified Lyerly-Poppen operation involved tissue only medial to the lateral ventricles; and this caused no permanent disorder of micturition, except in one case. So it seems to cause this syndrome, permanently, some of the white matter lateral to the ventricles has to be involved or some of the grey matter. The whole syndrome can occur following a unilateral lesion in this area. The region involved is best seen on a coronal section of the frontal lobes. Such a section is shown as Fig. 7. It will be seen that a lesion lying just lateral and slightly superior to the corpus callosum will involve most of the fibres of the white matter running into and out of the genu of the corpus callosum, fibres running to and from the superior frontal gyrus, and some fibres to and from the middle frontal gyrus and the anterior part of the cingulate gyrus. This is the

![Fig. 7. Coronal section of brain at level of tips of lateral ventricles, about 4 cm posterior to the frontal poles. A lesion just lateral to the corpus callosum and beneath the superior and middle frontal gyrus in this plane causes the syndrome described here.](image)
region of the medial frontal lobe involved in all the lesion. I would now like
to stress the following practical point:—1) Disturbances of micturition and/or
defaecation of the kind described here should suggest to us that the lesion giving
rise to them is located in this part of one or both frontal lobes. 2) It seems that
when sudden incontinence is a part of an epileptic fit, the lesion may be here.
3) The choice of operation of leucotomy should consider the possibility of these
permanent disturbances of micturition occurring. This should be one of the
factors influencing the choice of operation.

I will now summarize what I have said: There is a relationship between
the control of micturition and defaecation and the region of the dysgranular
area of cortex of the superior frontal gyrus. A lesion here is likely to cause
severe urgency and frequency of micturition and incontinence both when the
patient is awake and asleep. This is not merely a mental incontinence. There
is always a loss of the sensation giving rise to the desire to micturate; and there
may be a loss of all sensations associated with micturition, so that the patient
passes urine without being aware of doing so. There is great or complete impair-
ment of the ability to prevent the micturition reflex from occurring and of stopping
it continuing to empting of the bladder once it has occurred. The micturition
reflex occurs far earlier than in the normal, so that micturition is liable to occur
when the bladder contains only 100 to 150 ml of urine. In this respect the
bladder behaves like a bladder when the spinal cord has been transected. Bladder
tone is normal. There is the same disorder with regard to defaecation, although
it is less severe. Although the syndrome occurs with lesions of both frontal lobes,
the minimal lesion causing it may be restricted to one lobe.