Disturbances of Micturition and Defaecation due to Aneurysms of Anterior Communicating or Anterior Cerebral Arteries

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It was shown by Andrew and Nathan in a previous paper that lesions of a medial anterior region of the frontal lobes cause disturbances of micturition and less often of defaecation. The disorder consists of frequency and urgency of micturition, perhaps leading to incontinence. The patient has a reduced awareness of all vesical events; the sensation giving rise to the desire to micturate is diminished or absent, and the sensation that micturition is imminent may also be diminished or lost. All sensations associated with micturition may be lacking. The bladder empties when it contains less than the normal amount of urine, so that its functional capacity becomes reduced. There is also a partial or complete impairment of the ability to suppress the micturition reflex or to inhibit it once it has begun. Sometimes there is the same disorder of defaecation, although this is less common and less severe. A lesion in the same region of the brain sometimes causes retention of urine, associated with the same loss of awareness. The location of the lesion causing these disturbances was shown to be that region of the superior frontal gyrus where areas FB and FC overlap; its lateral extent is a little lateral to the tip of the lateral ventricles. The region includes the parts of the frontal lobe deep to this region of cortex and involves some of area LA of the anterior cingulate area. This region of the brain is shown in Fig. 1, a, b, and c.

The purpose of the present paper is to present a group of cases, showing that disturbances of micturition and defaecation can occur with aneurysms affecting the region where the rostral part of the diencephalon meets the telencephalon; to correlate these lesions with our present knowledge of the anatomy of this part of the brain; to suggest a relationship between the two parts of the brain lesions which cause the same clinical state; and to draw attention to these disturbances as localising symptoms and signs of lesions in these parts of the brain.

Case Reports

Case 1. Mrs. M.S. Two days before admission to hospital this 55-year-old woman suddenly developed severe headache which was followed by vomiting and then drowsiness. A lumbar puncture confirmed the diagnosis of spontaneous subarachnoid haemorrhage. On admission to the Neurosurgical Centre, the patient was alert and orientated; there was hesitancy in naming objects; the tendon reflexes of the right limbs were exaggerated, and both plantar responses were normal. Carotid angiography showed an aneurysm projecting forwards from the anterior communicating artery (Fig. 2).

On the fourth day after the haemorrhage, a right-sided frontotemporal craniotomy was performed under hypothermia. The frontal lobe was elevated, and a sub-pial resection of the grey matter of part of the gyrus rectus was carried out above the optic foramen. The aneurysm came into view, and its neck was clipped satisfactorily.

After this operation the patient regained consciousness within an hour. She was very slightly drowsy for 3 days, and then became normally alert. There was no change in the neurological signs.

The patient was completely incontinent of urine for 14 days after this operation. She was much distressed by this incontinence as she knew that it was delaying her return home. She stated that she did not know that her bladder was full until micturition was imminent, and then she was unable to hold urine for more than a minute. She could micturate normally and residual urine was no more than a few ml. Normal bladder sensation gradually returned, and with it, normal control.

Case 2. Mrs. C.M. We report this case through the kindness of Mr. Valentine Logue. This 46-
year-old woman had already had 3 minor episodes of spontaneous subarachnoid haemorrhage due to rupture of an aneurysm of the anterior communicating artery. Bilateral carotid angiography showed that the aneurysm filled only from the right carotid injection; as there was no anomaly in the anterior part of the circle of Willis, it was decided to clip the right anterior cerebral artery, in order to reduce the risk of recurrent haemorrhage. At operation through a right fronto-temporal craniotomy, the right frontal lobe was elevated and the right anterior cerebral artery was clipped as it crossed the right optic nerve. After this operation the patient had a very slight weakness of the left side of the face and left upper limb, lasting a few days. She was totally incontinent of urine. This incontinence eventually improved, so that by 6 months after the operation, she was incontinent only during sleep and had frequency and urgency of micturition when awake; the incontinence during sleep occurred 2 or 3 times every night; when awake she passed urine about once an hour. The patient was distressed by these symptoms. She said she had very little warning of when she wanted to pass urine, and then the urine just passed. Investigation of these symptoms at another hospital to which she had been sent by her general practitioner failed to reveal any gynaecological or urological cause for them. A cystogram carried out 2 years after the operation on the aneurysm is shown in Fig. 3. When the catheter was passed, there were 120 ml of residual urine. The pressure rose rapidly to 10 cm., and remained rather high throughout, though not beyond the limits of the normal. The most abnormal feature was the frequent occurrence of detrusor contractions, which started when the bladder contained less than 100 ml of fluid; she could not stop these contractions. A normal feeling of fullness developed after 350 ml had been dripped in which increased with the fluid volume.

Case 3. Mr. L.B. This 38-year-old man, while watching television, suddenly developed severe headache, followed by vomiting. The patient did not lose consciousness, but he was amnesic for the events of the following half hour. On admission to the Regional Centre of Neurosurgery, 36 hours after the onset of his illness, he was conscious, normally orientated, and had severe meningism. There was a very slight weakness of the right side of the face and the right upper limb; the plantar
Abnormal Micturition Due to Aneurysm

Fig. 1 b and c. Superolateral (above), and medial (below) views of left hemisphere showing location of region particularly important for the control of micturition and defaecation.
responses were equivocal. The bladder was greatly distended, as the patient had not passed urine since the haemorrhage, 36 hours before. He was unaware of this distension, and pressure over the bladder caused no pain. One and a half litres of urine were removed by catheterization. Lumbar puncture confirmed the diagnosis of subarachnoid haemorrhage. Carotid angiography performed 6 days after the haemorrhage showed an aneurysm arising from the anterior communicating artery (Fig. 4); both anterior cerebral arteries filled from the left internal carotid artery.

A cystometrogram was performed. After 270 ml. of water had been dripped into the bladder, and the pressure was only 4 cm. of water, the patient admitted to a vague feeling of fullness but as filling of the bladder continued this sensation passed off. After 600 ml. had been dripped in, and the pressure was 10 cm. the test was stopped; there was then no feeling of fullness and the patient stated in answer to questions that he had no
desire the micturate and felt no pain. When the patient was then urged to micturate, he was unable to increase the intravascular pressure.

At operation the left frontal pole was amputated and the aneurysm exposed. Two tantalum clips were placed across its neck, and the collapsed sac was invested with acrylic. No evidence of a haematoma was seen, although there was blood staining of the meninges around the aneurysm.

After the operation the patient was drowsy and showed slight aphasia for 3 days: then he returned rapidly to his preoperative state. The catheter was removed 7 days after the operation; for the next 4 days, micturition took place only following injections of urocholine; after that the patient considered his micturition to be normal. Seventeen days after operation a cystometrogram was performed, and 15 ml. of residual urine were found. After 100 ml. had been dripped into the bladder and the pressure had risen to 14 cm., the patient said his bladder felt full; this feeling became intense after 300 ml. had been dripped in and the pressure was 20 cm. When the patient was then told to try to micturate, the pressure rose rapidly to 60 cm. This cystometrogram was considered normal.

**Case 4.** Mrs. M.M. Following operation for removal of a meningioma of the falk, this 38-year-old patient was sent back to hospital because of a subarachnoid haemorrhage. Carotid angiography showed that an aneurysm had developed on the right anterior cerebral artery, posterior to the genu of the corpus callosum (Fig. 5). The patient was mentally alert and normal; she had very slight weakness in the left lower limb and the left plantar response was of the Babinski type. The patient was incontinent of urine once, although she was fully conscious; on being questioned about this, she said that she had no desire to micturate, she just found she had done so. After being incontinent on this occasion, she did not micturate again spontaneously, and when asked to pass urine, she found that she could not do so. A cystometrogram was performed. She experienced some feeling of fullness after 400 ml. of water had been dripped in; there were no detrusor contractions, and the patient could not induce any when urged to try to micturate.

The craniotomy was re-opened. A 20 ml. haematoma cavity was found, which was partly subdural and partly intracerebral, on the medial aspect of the right frontal lobe, extending from 2 cm. behind the genu of the corpus callosum backwards; superiorly it extended to within 2 cm. of the superior medial border of the hemisphere, and inferiorly, to the cingulate gyrus. The clot was evacuated, and the neck of the aneurysm was ligated.

Immediately after this operation spontaneous micturition occurred, and incontinence of urine followed for 2 days. When the cystometrogram was repeated one week after the operation, it was normal.

The haematoma had been compressing the medial aspect of the right frontal lobe near the genu of the corpus callosum, immediately above

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**Fig. 4.** Left carotid arteriogram: oblique view; showing an aneurysm arising from the anterior communicating artery and both anterior cerebral arteries, filling from the left side.

**Fig. 5.** Right carotid arteriogram: lateral view; showing an aneurysm on the pericallosal artery 4 cm. behind the genu of the corpus callosum. The previously made bone flap can be seen.
the cingulate gyrus. This lesion caused retention of urine with a lack of spontaneous or inducible micturition reflexes. Evacuation of the clot restored normal micturition.

**Case 5.** Mrs. C.S. This 62-year-old woman was admitted to hospital with a spontaneous subarachnoid haemorrhage. She had not lost consciousness, but had suddenly developed a severe headache, had vomited several times, and had then become drowsy. A lumbar puncture confirmed the diagnosis. On examination 5 days later it was found that the patient was alert but somewhat confused and disorientated; there was a slight left hemiparesis, and both plantar responses were of the Babinski type. She was incontinent of urine. On questioning she said that she had no feeling of bladder distension and no warning that she was about to pass urine; she merely found that she had done so.

Cystometry carried out at this time revealed a few ml of residual urine. After 100 ml of fluid had been dripped in and the pressure was 5 cm., there was a spontaneous detrusor contraction raising the pressure to 100 cm, and causing the fluid to leak around the catheter. There had been no sensation of fullness or any sensation of needing to micturate and no sensation accompanying or preceding the detrusor contraction; the patient was unable to inhibit this contraction.

Angiography revealed an aneurysm arising from the left pericallosal artery at the point of origin of the left callosomarginal artery (Fig. 6). At operation a haematoma cavity was found 2 cm. long in the left cingulate gyrus. The fundus of the aneurysm was seen projecting into the haematoma at its anterior end, over the genu of the corpus callosum; its neck was ligated. The haematoma contained about 8 ml of altered blood, which was then evacuated.

For 2 weeks after the operation the patient was mildly confused and euphoric, and during this time she was always incontinent of urine. Four weeks later she had become continent when awake but incontinent when asleep. The cystometrogram was then repeated. After 100 ml of fluid had been dripped in, a spontaneous detrusor contraction occurred taking the pressure up to 40 cm.; the patient felt this and was able to inhibit it on command. After 300 ml had been dripped in, there was a further strong detrusor contraction, and this she could not inhibit. A comparison of this with the preoperative record showed that the functional capacity of the bladder had increased, that detrusor contractions were now associated with sensation, and that they could be inhibited to some extent. There was still none of the normal sensation associated with gradual filling of the bladder.

When this patient was seen 2 years, 3 months later, she was wetting her bed about once a month and was incontinent of urine when up, about once a week. She said she had little warning of when her bladder was about to empty, and, if she drank too much fluid, she never dared go too far from the toilet. She was much upset by this persisting incontinence. On one occasion since the operation she had had diarrhoea; at that time she had twice been incontinent of faeces.

**Case 6.** Mr. J.S. This patient was sent in from another hospital, deeply unconscious. For the past 18 months the patient had been having bouts, about 6 in all, of severe diarrhoea, accompanied by loss of consciousness. The diarrhoea was not associated with a fever or with any systemic symptoms. He would have his bowels open about 6 times a day, passing a watery motion, without blood or mucus or pus. During the day on which he had the diarrhoea he also had several attacks of loss of consciousness. These would come on without a warning; he would fall to the ground. He was unconscious for periods up to 20 minutes; during this time his face was red and his eyes were staring, but there were no clonic movements, no biting of his tongue, no incontinence of urine; his breathing was stertorous. He had been investigated in the Westminster Hospital; the barium meal and barium enema were normal, and no cause for the diarrhoea had been found. These attacks of

![Fig. 6. Left carotid arteriogram: lateral view; showing a bilocular aneurysm arising in the angle between the pericallosal and the callosomarginal arteries.](image-url)
diarrhoea and of unconsciousness had necessitated giving up his employment as a policeman.

On the day he was admitted to hospital, he had suddenly fallen unconscious striking his head as he fell. After three quarters of an hour, he regained consciousness, and complained only of a very severe headache. He then vomited, lost consciousness and never regained it. Lumbar puncture revealed heavily blood-stained cerebrospinal fluid. He died within 12 hours of admission.

At postmortem, the entire alimentary system, kidneys, ureter and bladder were found to be normal. Dissection of the circle of Willis revealed a ruptured saccular aneurysm of the anterior communicating artery, extending superiorly and to the right. Its maximum dimension was about 0.5 cm.

The haemorrhage from the rupture had tracked into the anterior horn of the right lateral ventricle, destroying the right parolfactory area and giving rise to haemorrhagic discolouration in the area immediately inferior to the genu of the corpus callosum. No gross lesion was seen in the hypothalamus. A photograph of the aneurysm is shown in Fig. 7.

Discussion

The cases presented in this paper fall into two groups: aneurysms of the anterior cerebral artery near the genu of the corpus callosum and aneurysms of the anterior communicating artery. The anterior cerebral arteries, as they curve around the genu of the corpus callosum, supply the septum pellucidum, the lamina terminalis, and the preoptic area. The anterior and basal parts of the hypothalamus are supplied by the anterior medial ganglionic arteries. The blood supply of this region of the brain was studied by Foley et al., Rubinstein, and Lazorthes et al. Foley et al. showed by performing selective injections that the septal region, including the medial and lateral preoptic areas, is well supplied by the anterior cerebral arteries; it also receives blood from the anterior group of hypothalamic arteries, which supply the anterior hypothalamus. These branches arise from the anterior cerebral or anterior communicating arteries. They may also arise from the internal carotid artery itself, "from that point of the dorsal wall where it bifurcates into the anterior and middle cerebral."

Dott has presented evidence to show that sudden stretching of an artery causes spasm of its walls. He considers that aneurysms affecting the circle of Willis cause ischaemic changes in the diencephalon. The expansion of the aneurysm and/or its rupture stretches and distorts the arteries arising from the relatively fixed circle of Willis, and this causes spasm or occlusion of the arteries. Ischaemic lesions of the hypothalamus due to rupture of berry aneurysms have been reported by Crompto; the aneurysms most likely to produce these lesions were aneurysms of the anterior and posterior communicating arteries. The commonest ischaemic lesion was shown to be infarction. Bilateral infarction was found to be commoner with aneurysms on or near the midline.

In our previous paper we showed that lesions of the cingulate gyrus involving area LA in its pre-genual part and its anterior superior part cause frequency and urgency of micturition during waking hours and in-
continence during sleep; but with these lesions there was no disturbance of defaecation and the symptoms were not permanent. These parts of the limbic lobes are also supplied by the anterior cerebral arteries.

Although it does not seem to have been commonly realised that lesions of the preoptic and septal region, the grey matter abutting against the lamina terminalis and anterior commissure including Johnson's parolfactory area, and the rostral and ventral part of the hypothalamus cause these disturbances of micturition and defaecation as well as disturbances of libido and potency, there are cases in the literature showing the same clinical picture as is reported here. We have seen a similar case due to an arachnoidal cyst of the optic chiasma cured by needling of the cyst.

Spillane reported the cases of 5 boxers with the punch-drunk syndrome. Two of these boxers had urgency and frequency of micturition; one had incontinence and the other had occasional retention of urine. Of these 2, one had gross thinning, and the other absence, of the septum pellucidum. It is possible that repeated concussion would lead to repeated and prolonged spasm of blood vessels which are stretched with the movement of the brain, and that this would eventually lead to permanent ischaemia, hypoxia or infarction in their territory.

Cases of tumours arising in the septum pellucidum have been reported by French and Bucy and by Castaigne et al. Incontinence was present in 3 of French and Bucy's 5 patients. Their first case was a man who had symptoms of peptic ulceration prior to his cerebral symptoms. Following the removal of a discrete encapsulated tumour occupying the septum pellucidum the patient made an excellent recovery but after leaving hospital "he occasionally urinated involuntarily." Their second patient, who in another hospital had been thought to be suffering from a purely mental disease, had a more extensive tumour which dis tended the anterior part of the left lateral ventricle. He was incontinent at times for some while after the removal of the tumour, and he once suffered from gastro-intestinal haemorrhage. Even years after the removal of the tumour, the only possibly related symptom was persisting constipation. Castaigne et al.'s third case of tumours of the septum pellucidum had "une incontinence sphinctérienne."

The most important and detailed investigation of the functions of the part of the brain disturbed by these aneurysms is that of Hess and his colleagues. In anaesthetised unrestricted cats, micturition and defaecation, including the preparatory searching for a suitable place and the associated movements and posture of the total musculature and skeleton, is brought about by stimulation of the septum pellucidum and a region from the septum pellucidum downwards through the preoptic and supraoptic area to the anterior hypothalamus. Within the hypothalamus the nearer the region is to the midline, the more likely is stimulation to make the animal micturate or defaecate. Hess showed that the complete act of micturition and defaecation during which the cat took up the position typical of normal cats performing these functions was obtained from stimulating the ventral part of the septum pellucidum, the bed of the stria terminalis and the anterior and lateral parts of the basal hypothalamus. Stimulation of the more posterior basal parts of the hypothalamus made the cats pass urine without taking up the total position of micturition. Hess considered that the hypothalamus organised the visceral component of micturition and that the septal nuclei organised the participation of the skeleton and the somatic musculature in this act.

The septal nuclei, including the grey matter around the anterior commissure, it should be understood, are not a part of the septum pellucidum. They are a part of the preoptic area and are connected to the hippocampus and amygdala above and the hypothalamus below. This is phylogenetically a very old part of the brain; it was present in the lowest fishes, and developed before the cerebral hemispheres, the corpus callosum, and the septum pellucidum.

Acute experiments on anaesthetised cats, dogs, and rabbits, fit in with Hess's observations on living and freely moving animals. In these three species, Ranson et al. obtained contraction of the bladder by stimulating the septum pellucidum just beneath the corpus callosum and the region just lateral to the septum and rostral to the
anterior commissure, the region surrounding the anterior commissure, and the adjacent part of the septum and the preoptic area. More posteriorly, they obtained bladder contraction from stimulating the lateral hypothalamus near the optic chiasm, the supraoptic commissure below the third ventricle, the supramammillary commissure, the perifornical nucleus just rostral to the mammillary bodies, the grey matter of the tuber cinereum ventral to the fornix and the posterior hypothalamic nucleus. They also traced the region further posteriorly; but this region does not concern us here.

Grossman and Wang\textsuperscript{41} and Skultety\textsuperscript{32} confirmed their findings in the cat. In the rabbit, Yokayama \textit{et al.}\textsuperscript{44} obtained contraction of the bladder by stimulating the anterior part of the cingulum, the septal nuclei, the nucleus accumbens and the olfactory tubercle, the preoptic paraventricular layer and the lateral preoptic area. Relaxation of the bladder or relaxation following initial contraction was obtained by stimulating the medial preoptic area, ventromedial, dorsomedial, anterior and posterior hypothalamic nuclei, supraoptic and paraventricular nuclei and the lateral mammillary nucleus. They obtained change in posture of the rabbit, “the somatic movement of urination” as well as contraction of the bladder by stimulating the paraventricular layer, the medial mammillary nucleus, the mammillo-tingmental tract and the lateral hypothalamic nucleus.

Stimulation studies performed in the hypothalamus and in the septal region of conscious patients have been carried out by Heath.\textsuperscript{12} Of his 27 cases, only 1 patient mentioned any symptoms connected with the bladder, and she complained of urgency of micturition. When this was so, the point of stimulation was directly below the foramen of Monro, 2 mm. from the midline, and it is probable that the electrode tip was either in the ventro-medial nucleus of the hypothalamus or between this nucleus and the nucleus lateralis tuberis cineri.

The total acts of micturition and defaecation are organised below the level of the neopallium. The decorticate dogs of Goltz\textsuperscript{10} and Rothmann\textsuperscript{20} and cats of Dusser de Barenne\textsuperscript{28} were able to micturate and defaecate normally, taking up the position and performing all movements proper to their species. The integration of these acts into the behaviour of the animal is the function of the cerebral hemispheres. And the part of these structures concerned is, we suggest, that section of the frontal lobe previously described by Andrew and Nathan.\textsuperscript{1} This part of the forebrain is very close to the septum pellucidum and the preoptic region, and the latter is only just rostral to the rostro-ventral parts of the hypothalamus within which micturition and defaecation are organised. We suggest that the cortical area controls, excites and inhibits the preoptic region and the anterior hypothalamic area, and to exercise this control it receives the necessary information concerning rectal and vesical events.

It has recently been shown in the cat by Gjone and Setekleiv\textsuperscript{44} that stimulation of the supracallosal part of the anterior cingulate gyrus causes detrusor contractions going on to the complete act of micturition, and that stimulation of the subcallosal part of the gyrus and of the orbital gyrus causes a diminution in detrusor contractions, interruption of the act of micturition, and if persisted in, prevention of the onset of micturition. As mentioned in our previous paper, the evidence in man excludes the orbital cortex from the function of micturition or defaecation; otherwise this experimental work serves to confirm the anterior callosal region as being important for micturition, which was deduced from clinical observations.

In clinical cases, it seems probable that when the frontal or the anterior cingulate cortical regions are damaged or cut off from the septal and hypothalamic areas, micturition and defaecation proceed automatically, involuntarily; little or no information related to these acts reaches consciousness. When the preoptic region is destroyed, as in aneurysms of the anterior communicating and anterior cerebral arteries, the result is the same. These acts are organised at a sub-cortical level, and no cortical control is possible.

\textbf{Summary}

Aneurysms of the anterior communicating artery of the anterior cerebral arteries may cause the following disturbances of micturi-
tion and defaecation; frequency and urgency leading to incontinence with incontinence during sleep; a lack of awareness of all vesical events; an inability to suppress the micturition reflex or to inhibit this reflex once it has begun; occasionally, retention of urine.

We believe that these aneurysms cause ischaemia by interfering with the blood supply of the septal and preoptic region of the telencephalon and the rostral part of the hypothalamus.

The relationship between a region of the superior frontal gyrus and the anterior part of the cingulate gyrus and the affected regions of the septal grey matter, the preoptic area and the antero-ventral part of the hypothalamus has been considered. We have suggested that these cortical areas normally excite, inhibit and control the basal areas. Lesions of the cortical areas or of the preoptic-diencephalic areas cause the same disorders, for they both disturb the cerebral organisation of micturition and defaecation.

References