J R Coll Physicians Edinb 2019; 49: 70–7 | doi: 10.4997/JRCPE.2019.115 **PAPER**

Neurosurgery in Aberdeen Royal Infirmary *c.* 1920–*c.*1940: knowledge, skills and styles

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History & Humanities

Abstract

A neurosurgical unit was established in Aberdeen Royal Infirmary (ARI) in 1948 with the appointment of Martin Nichols as its first full-time neurosurgeon. Despite there being no formal neurosurgical ward or specialist dedicated to neurosurgery in ARI prior to this, a number of neurosurgical procedures were undertaken between 1920 and 1940. From 1923 to 1932, the procedures were predominantly cranial and were performed by general surgeons. The operations evolved in 1933 to include the spine and peripheral nerves after the arrival of Sir James Learmonth. This paper chronicles the development of surgical neurology at the ARI in the 30 years preceding a formal unit. It considers the factors and background that enabled neurosurgical practices to be undertaken and led to evolution of neurosurgery from general surgery.

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Keywords: Aberdeen Royal Infirmary, Henry Gray, James Learmonth, neurosurgery, William Anderson

Financial and Competing Interests: No conflict of interests declared

Introduction

The field of neurosurgery has a rich and fascinating history. Much of the literature on the history of Scottish neurosurgery focuses primarily on the innovative work of Sir William Macewan (1848–1924) in Glasgow,[1] and the establishment of the modern era through Norman Dott (1897–1973) of Edinburgh.[2] Development of this speciality has been mapped in several institutions but documentation of its history in Aberdeen Royal Infirmary (ARI) has been limited. Levack and Dudley made a brief description regarding the inception of the neurosurgical ward in 1948 through the appointment of Martin Nichols.[3] They further acknowledged that prior to the appointment of Nichols, it was William Anderson (1886–1949) who led surgical practice in Aberdeen during the Second World War (WWII) with his 'pioneering work in neurological and thoracic surgery'. This was repeated by Casper's authoritative work on British neurology.[4] There is evidence that neurosurgical practices were being undertaken in the Infirmary prior to WWII and to Nichols' appointment.[5–25] It has been shown that several surgeons working in ARI between 1920 and 1940 were well versed in neurosurgical practices; with one having published on the basic management principles of cranial and spinal injuries during the First World War (WWI)[26,27] and another having trained in North America alongside the innovators in the field of neurosurgery.[28] Yet no formal documentation has been made with respect to those surgeons performing neurosurgical procedures, the types of procedures that were undertaken and the background that enabled these practices to be carried out.

To help inform this gap in the literature, this paper chronicles the development of neurosurgery in ARI during the early twentieth century. A large body of evidence sourced from the National Health Service (NHS) Grampian Operations Log Books and Statistical Table of Procedural Cases has been utilised to show its early development. Examination of neurosurgical research during the early twentieth century and the review of publications by key surgeons demonstrates the neurosurgical knowledge available during that time and confirms that surgeons were able carry out certain neurosurgical procedures.

By considering the mentors and the institutions where the surgeons worked, their surgical style can be deduced. Archival sources from the Society of British Neurological Surgeons have been examined to understand the influences of the medical societies in the fostering of particular styles, negotiating surgical knowledge and demonstrating surgical skills. The study will demonstrate the period during which neurosurgery emerged as an independent clinical discipline in ARI and consider the factors that enabled this evolution.

General surgery and the emergence of neurosurgery

Historically, Great Britain had many prominent figures in neurosurgery. The Glaswegian, Sir William Macewan, diagnosed, localised and resected a cranial tumour in 1879 and performed further cranial operations for trauma and infection.[29] Sir Victor Horsley contributed to the understanding

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of epilepsy and was an innovator in spinal tumour surgery and brain surgery. He also carried out experimental studies on animals to establish the neurophysiological principles underlying human neurosurgery.[30] Notably, both these surgeons began their careers in general surgery.

At the beginning of the twentieth century, neurosurgery was not considered a distinct speciality in Great Britain and neurosurgical procedures were mainly undertaken by general surgeons with an interest in the nervous system.[31,32] Standards were not codified, so the early twentieth century was a time for great adventure in surgery.[33] Although there were no set guidelines for neurosurgical procedures, research publications and surgical teaching played a key role in the dissemination of the knowledge, skills and surgical styles required. Experience in the management of head and spinal wounds sustained during WWI further contributed towards the evolution of this speciality.[34,35]

As neurosurgery was in its infancy, it was devoid of any standard protocols. The surgical technique adopted by surgeons wishing to operate on the nervous system was of paramount importance for the undertaking of these procedures. In neurosurgery, this surgical technique was shaped during the early twentieth century by the American founding father and then undisputed leader of neurosurgery at the time, Harvey Cushing (1869–1939). Cushing advocated a slow, meticulous operative style. He changed the rules of good surgery from '…the stirring, slap-dash, and spectacular' to the 'quiet, patient, and undramatic performance'. Although this was regarded as a 'tedious and dull show', it meant that this slow, careful performance with delicate tissue handling led to a reduction in mortality.[36]

The way to acquire a surgical technique was through the imitation of others and by operative experience.[37] During the 1920s three British men had become interested in surgery on the nervous system and had appreciated the importance of learning this technique directly from the innovators. Hugh Cairns in London, Jeffery Geofferson in Manchester and Norman Dott in Edinburgh, independently went on to train in Boston under the tutelage of Cushing.[32] They adopted Cushing's principles and brought back his influences to Great Britain, implementing his neurosurgical techniques in their institutions, disseminating his methods to others and leading neurosurgical practices during the 1920s.[32]

During that time, more sophisticated approaches towards brain surgery and tumour diagnosis were also being developed, which contributed towards better outcomes for neurosurgical patients. The creation of pneumoencephalography and X-ray allowed for a gross localisation of space-occupying lesions.[38] Anaesthesia, aseptics and antiseptics were available, which permitted a relatively safe operation and a reduction in postoperative mortality.[39] Patient case studies, and descriptions and illustrations of surgical approaches were disseminated in research publications, providing surgeons wishing to operate on the nervous system with relevant up-to-date information. With this knowledge base, surgery on the nervous system began to propagate throughout Great Britain to a number of institutions, including Aberdeen where it became integrated into the hospitals' practices.

Figure 1 Sir Henry MW Gray. Reproduced with kind permission from Ann Boyer and Thomas Scotland[40]

Evidence from the earliest surviving records from the 'Aberdeen Royal Infirmary Statistical Tables of Procedural Cases' – a list of the admissions, treatments and clinical outcomes – show that neurosurgical procedures were being undertaken in 1923.[5] These operations comprised cerebral decompressions, trepanations and excision of brain tumours. It is further reported that in subsequent years this practice of neurosurgery continued. The procedures now expanded to include peripheral nerve operations, consisting of both the suturing[9] and transplantation of the ulnar nerve,[10] and the repair of the brachial plexus.[11] Although the presenting complaint and the type of surgical procedure were well documented, the operating surgeon and any surgical notes were, however, not documented. It is therefore difficult to trace the surgeon who performed neurosurgery from these times as specific records are scarce.

The development of neurosurgery is acknowledged to have had a large military component[34,35] and the skills and knowledge acquired from WWI clearly played a major role in Aberdeen. Many general surgeons from ARI were serving as surgeons during the war. One worthy of special mention is Sir Henry MW Gray (1870–1938), who was a Consultant Surgeon to ARI from 1904. Gray (Figure 1)[40] was described as a 'courageous, industrious Aberdonian surgeon of great

Table 1 Neurosurgical procedures carried out in Aberdeen Royal Infirmary during 1929[17]

Presentation	Surgery	Surgeon
Cerebellar tumour	Part excision	W Anderson
Cerebellopontine-angle tumour	Resection	W Anderson
Cerebellar tumour	Decompression	J Marnoch
Cerebral tumour	Decompression	W Anderson
Cerebellopontine-angle tumour	Not removed	W Anderson
Cerebral neoplasm	Double decompression	W Anderson

integrity and innovative flair'.[40] He had a wealth of knowledge in a number of systems and his surgical list could include plating of a fracture, cerebral decompression and resection of a bladder.[3]

During WWI, Gray made a number of notable contributions. He was the first consulting surgeon to employ wound excision, which is the early radical removal of all devitalised tissue and foreign material from filthy contaminated wounds, thereby reducing the probability of overwhelming wound infections.[41] He revolutionised the management of compound fractures to the femur[42] and the treatment of gunshot wounds to the knee.[43] His military skills, his experiences from the sheer volume of patients with cranio-spinal trauma and his large scope of surgical knowledge led to him establishing the basic management principles for cranial and spinal trauma,[26,27] where, once again, the principle of early excision of devitalised tissue was advocated.

Gray developed and applied several novel techniques in surgery of the brain during his time in France. He advocated digital exploration of the brain wound track from a foreign body and deemed it inoperable if beyond the reach of a finger. He supported incising the intact dura to remove an underlying clot. He would encourage the awake patient under local anaesthesia to cough to expel necrotic pulped brain tissue.[26] To permit these operations to the head, the control of blood loss was imperative. Indeed, Gray devised a procedure to control the pain and bleeding: the use of a local anaesthesia and adrenaline mixture. Gray's concepts were widely disseminated, with surgeons advocating these principles in their operations during the war.[44] This meant that the knowledge base, surgical skills and styles disseminated between the surgeons in the war could be modified, transferred to civilian life and implemented in neurosurgical practices in ARI.

Another Aberdonian surgeon, William Anderson, also made notable contributions during the war. Anderson graduated from the University of Aberdeen in 1909. He served as House Physician and House Surgeon at ARI under Gray, and as a resident at the Royal Aberdeen Children's Hospital.[45] During WWI, Anderson served as a surgical specialist in charge of No. 12 Stationary Hospital. He developed an extensive portfolio of surgical cases and these experiences enabled him to expand on his knowledge of human anatomy, an understanding of which was crucial for his practice of neurosurgery:

> I knew my anatomy really well. Between 1912 and 1923 I had war surgery in France; and from that I came to realise how accurately a surgeon has to know his anatomy and how greatly it helps to examine a patient and picture what lies beneath the skin. [46]

The year 1929 saw Anderson dominate neurosurgical practices in ARI (Table 1). From 1929 to 1932, Anderson and Sir John Marnoch, Regius Professor of Surgery, were the two principal surgeons carrying out neurosurgical cases.[17,18] Anderson's main interests lay in abdominal and thoracic surgery,[46] but he also paid close attention to the developing speciality of neurosurgery. He travelled across Europe and America, eager to keep abreast of the latest developments in this field. He followed Cushing's work and after a visit to America, he 'referred in some detail, and with great admiration, to the neurological surgery done by Cushing'.[47]

Anderson mainly carried out decompression and excision of brain tumours.[17,18] He performed particularly difficult surgeries of the posterior fossa, one being the removal of cerebello-pontine angle tumours.[17] Recognised even today as extremely difficult, complicated surgery, this is an area of the brain rich in blood supply, where crucial blood vessels and cranial nerves transverse. It is an area referred to as the 'bloody angle'.[48] Surgery in this region requires a confident, meticulous approach, a sound knowledge of anatomy and great surgical skill.

Anderson had acquired a specific blend of the necessary skills required for this type of surgery. He had become well acquainted with war wounds involving the arteries and the delicate surgical approaches required to deal with them. His paper on 'Contusion of Arteries' elegantly detailed the surgical style he used when treating these wounds.[49] Anderson's knowledge of anatomy, wartime experience, and the teaching and guidance from his mentor, Gray, could additionally be utilised. Moreover, the approach to this type of surgery and case studies were available in the form of publications to help lead surgeons in the procedure. Research into the functions of the cerebellum and cerebellar surgery were well documented and recognised owing to the exposure to large numbers of skull fractures and occipital wounds attributed to the inadequate design of the British 'Brodie' helmets.[50,51] The American pioneer of brain surgery, Cushing, was experienced in tumours of the cerebello-pontine angle area and detailed his experiences and the entirety of his procedures in a monograph.[52]

Although the availability of tools and research, and the dissemination of skills, knowledge and surgical styles aided the general surgeons to perform neurosurgical procedures, the outcomes often were poor. Surgeons interested in surgery of the nervous system realised it was important to learn

from the innovators and to adopt their method to improve surgical outcomes.

North American neurosurgical techniques in a Scottish context

Examination of the NHS Grampian Operations Log Book beginning the year 1933 shows that the number of neurosurgical procedures in ARI increased (Table 2).[18,19] The types of procedures became more diverse, expanding to subdivisions of the nervous system and included several operations on the peripheral nerves and the spinal cord.[18,19] Neurosurgery was beginning to emerge from general surgery to form its own distinct speciality.

The principal reason for this development was the appointment of Sir James Learmonth (1895–1967) in 1932 as Regius Professor of Surgery. To understand how Learmonth (Figure 2) enabled this transition one must examine Learmonth's medical career, looking at his educators, his research and focus on the skills he acquired throughout his surgical career.

Learmonth enrolled to study medicine at the University of Glasgow in 1913. His studies were interrupted by the outbreak of WWI where he served in France as a commissioned officer in the King's Own Scottish Borderers. After the war, he returned to Glasgow and graduated in 1921. He continued his training at Glasgow's Western Infirmary from 1921 to 1922 where he was assistant surgeon to Professor Archibald Young.[53] Young was Professor of Pathology and a previous assistant to Sir William Macewan. He had worked as a neurologist at No. 4 Scottish General Hospital during WWI and gained extensive experience treating war wounds. His interests lay in pain relief, and he undertook several procedures, including periarterial sympathectomy, ganglionectomy and sympathetic trunk resection for the treatment of Raynaud's disease, Hirschsprung's disease and arthritis.[54] Not only did Young 'impart the importance of painstaking attention to detail' to Learmonth, but he helped influence his choice of speciality.[55]

Learmonth's research played a key role in his chosen career. Undertaking laboratory research was seen as a way to develop safe practice by refining neurosurgical technique, and by pre-empting problems that may arise during the surgery. This was advocated by Cushing who had argued that 'every young surgeon should begin to acquire his operative training in a series of operations on lower animals'.[36]

In 1924 Learmonth was elected to a Rockefeller fellowship at the Mayo Clinic, Minnesota, and came under the supervision of Alfred Adson (1887–1951).[53] Adson was interested in the sympathetic nervous system,[56] the spine and the spinal cord,[57] and was regarded as an innovator in the field. This subsequently led to Adson becoming the authoritative figure from whom surgical styles should be adopted. Whilst under the tutelage of Adson, Learmonth undertook research on the pathology of tumours of the spinal cord, in particular leptomeningiomas, the subject of his subsequent thesis.[58] He examined the pathology of these tumours and their

Table 2 Neurosurgical procedures carried out in Aberdeen Royal Infirmary during 1933[18,19]

Presentation	Surgery	Surgeon
Spinal cord tumour	Laminectomy	J Learmonth
Cerebral tumour	Decompression	J Learmonth
Cerebral tumour	Decompression	J Learmonth
Cerebral tumour	Subtemporal decompression	J Learmonth
Brain tumour	Decompression	J Learmonth
Brain tumour	Removal	W Anderson
Cerebral tumour	Removal	J Learmonth
Spinal tumour	Removal of tumour	J Learmonth
Cerebral tumour	Puncture of tumour	J Learmonth
Atrophy of the brain	Ventriculogram	J Learmonth
Facial paralysis	Closure of facial nerve	J Learmonth
Cerebral tumour	Subtemporal decompression	J Learmonth
Weakness of hand	Lumbar puncture	J Learmonth
Epilepsy	Encephalography	J Learmonth
Trigeminal neuralgia	Injection of nerve	J Learmonth
Cerebellar tumour	Exploration and ventricular puncture	J Learmonth
Cerebral abscess	Exploration and needling	J Learmonth
Raynaud's disease	Lumbar sympathectomy	J Learmonth
Raynaud's disease	Cervical sympathectomy	J Learmonth

histological structures. Through following Adson's patients, he was able to recognise the presentation of the disease and become competent in its surgical treatment. This was an experience 'which was to influence much of his surgical life'.[53] He felt 'much indebted to Dr Adson' for the opportunities and teaching he was given.[58] After returning to ARI in 1932, Learmonth performed laminectomies for spinal tumours and Von Recklinghausen's neurofibromatosis,[19–23] and diagnosed and removed a leptomeningioma of the spinal cord.[20]

Another area of research that interested Learmonth was the sympathetic nervous system. When he returned to the Mayo Clinic in 1928, following on from his tenure at Glasgow Western Infirmary, he took up the post of Associate Neurologic Surgeon and began to study the sympathetic innervation of the urinary bladder.[59] He focused on the anatomy of these nerve roots and the physiological responses to stimulation

Figure 2 Professor JR Learmonth. © University of Edinburgh

of the nerves. These experiences enabled Learmonth to not only develop a sound understanding of the anatomy and physiology of the autonomic nervous system, but enabled him to operate on it. Learmonth brought back and implemented the knowledge and skills necessary to perform unilateral and bilateral cervical and lumbar sympathectomies for peripheral vascular diseases.[18–22] His work in this branch of neurosurgery subsequently led to his carrying out a lumbar sympathectomy on King George VI for the treatment of thromboangiitis obliterans. He was knighted for this service.[53]

At the Mayo Clinic, Consultant Pathologist James Watson Kernohan taught Learmonth to distinguish between types of brain tumours and establish their operability. Kernohan was an early contributor to establishing neuropathology as its own entity.[60] Learmonth and Kernohan carried out much research distinguishing between tumours of the brain and their operative outcome.[61,62] In 1934 the ARI Operations Log Books began to document the classification of the type of brain tumours Learmonth was operating on. In 1938, a patient presented with a glioblastoma – a fast growing, aggressive tumour difficult to remove owing to its infiltrative nature – and instead of attempted removal, palliative decompression was carried out.[22]

Learmonth was engaged in teaching both students and colleagues in the Infirmary.[53] In 1933 he requested permission from the hospital board to grant his assistant, GAG Mitchell, the privilege of examining and aiding in the treatment of neurological cases on his ward.[63] This request was granted, and Mitchell went on to become clinical assistant in neurosurgery. Mitchell developed an interest in the sympathetic nervous system and carried out research dissecting the nerves of the abdominal and pelvic viscera, thereby providing a greater understanding of this system and establishing the optimal approach for this type of surgery.[64] Learmonth's teaching enabled Anderson, in 1936, to perform a sympathectomy for thromboangiitis obliterans.[21]

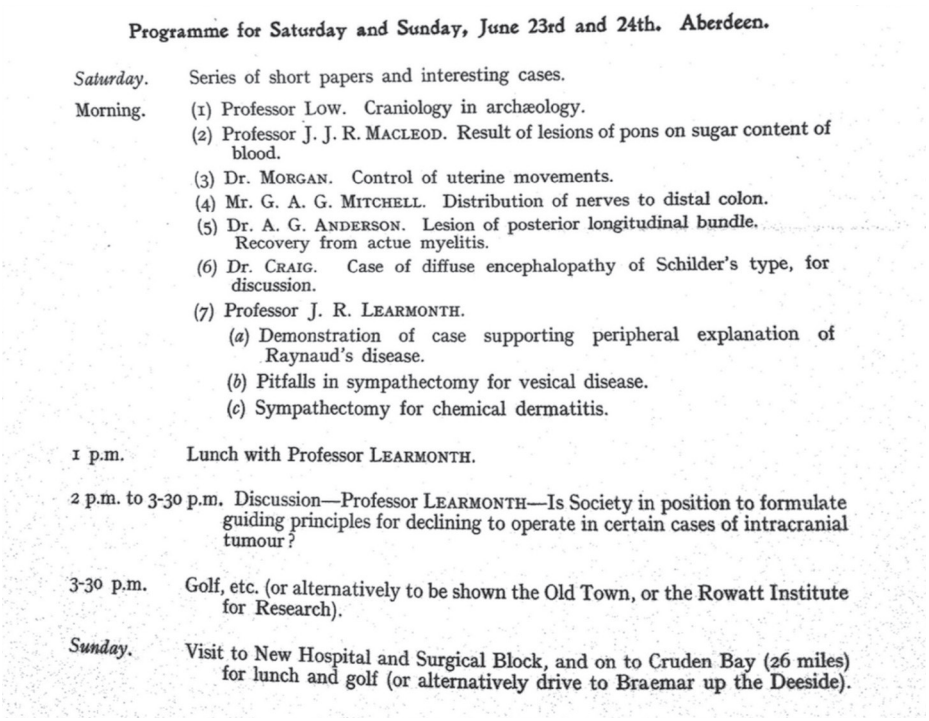
Institutionalising neurosurgery

Another element that ensured the success of neurosurgery in ARI was the role played by medical societies. One of these was the Society of British Neurological Surgeons (SBNS). Founded in 1926, it was modelled on the Society of Neurological Surgeons (SNS) – established by Harvey Cushing and Ernest Sachs 6 years earlier.[65] The vision of this society was to create a specialised association for surgeons dedicated to neurosurgery, to establish standards for neurosurgical procedures and to foster certain surgical styles.[36] Similar to the SNS, the SBNS was a small scientific club and the criterion for membership was an interest in neurosurgery.[66]

Learmonth was a founding member alongside other men including Jefferson, Dott and Cairns.[66] The society initially only had 15 members, each having a different area of expertise. This ranged from Charles Ballance's interests in neurotology and Wilfred Trotter's in subdural haematomas, to Learmonth's in the sympathetic nervous system. To exchange knowledge, skills and styles, the Society would meet twice per year during the Michaelmas and summer terms, initially in British units and subsequently in neurological clinics overseas. On occasions, joint meetings were held with American neurosurgical societies.[65,66] During these meetings, the host neurosurgeon would frequently demonstrate a procedure in his area of expertise, and this would subsequently lead to discussions and suggestions of a style to adopt, or certain tools to use.[65]

During the SBNS meeting held in ARI on the 24 November 1934, Learmonth gave a demonstration of a case supporting employment of a sympathectomy for Raynaud's disease.[67] He had been performing sympathectomies for Raynaud's frequently in the Infirmary and had conducted extensive research in this area. He was able to convey his scientific ideas and concepts, and to advise on the style of surgery he used.

The meeting also provided the opportunity for networking between SBNS members and Learmonth's colleagues in ARI. Learmonth invited his Aberdeen colleagues to give discussions to the group encompassing a range of neurosurgical elements (Figure 3). His assistant GAG Mitchell discussed the distribution of nerves to the distal colon;



Programme for Saturday and Sunday, June 23rd and 24th. Aberdeen.

Saturday. Series of short papers and interesting cases.

Morning.
(1) Professor Low. Craniology in archæology.
(2) Professor J. J. R. Macleod. Result of lesions of pons on sugar content of blood.
(3) Dr. Morgan. Control of uterine movements.
(4) Mr. G. A. G. Mitchell. Distribution of nerves to distal colon.
(5) Dr. A. G. Anderson. Lesion of posterior longitudinal bundle. Recovery from actue myelitis.
(6) Dr. Craig. Case of diffuse encephalopathy of Schilder's type, for discussion.
(7) Professor J. R. Learmonth.
(a) Demonstration of case supporting peripheral explanation of Raynaud's disease.
(b) Pitfalls in sympathectomy for vesical disease.
(c) Sympathectomy for chemical dermatitis.

1 p.m. Lunch with Professor Learmonth.

2 p.m. to 3-30 p.m. Discussion—Professor Learmonth—Is Society in position to formulate guiding principles for declining to operate in certain cases of intracranial tumour?

3-30 p.m. Golf, etc. (or alternatively to be shown the Old Town, or the Rowatt Institute for Research).

Sunday. Visit to New Hospital and Surgical Block, and on to Cruden Bay (26 miles) for lunch and golf (or alternatively drive to Braemar up the Deeside).

Figure 3 Programme of the 15th Society of British Neurological Surgeons meeting in Aberdeen. Reproduced with kind permission from the Society of British Neurological Surgeons[67]

Professor Alexander Low, lecturer in anatomy, presented cases in craniology in archaeology; Professor JJR McLeod, biochemist and physiologist involved in the discovery and isolation of insulin, reviewed the 'Results of lesions of pons on the sugar content of blood'; Dr Craig presented a case of diffuse encephalopathy of Schilder's type; and Dr AG Anderson discussed lesions of the posterior longitudinal bundle and recovery from acute myelitis.[67] This knowledge base and range of scientific expertise helped to consolidate the speciality in the Infirmary, and to establish Aberdeen as a centre of neurosurgical activities.

As well as disseminating his techniques and knowledge to others, Learmonth, through attending SBNS meetings, was able to acquire knowledge and apply new ideas to his surgical practice. By way of illustration, in 1936 Learmonth began to remove pituitary tumours in Aberdeen,[21] and this practice continued in subsequent years.[22] On 22 June 1934 in Edinburgh, Norman Dott gave a discussion on the removal of pituitary tumours and the causes of mortality and morbidity following transfrontal transcranial pituitary operations.[67] Dott had developed an extensive knowledge of pituitary tumours whilst working as assistant to Cushing in 1923.[68,69] Dott continued to research this field and refine the surgical approach in this type of surgery, and through his achievements was regarded as an expert in this field.[70] This meeting, along with others, meant that the range of procedures that could be undertaken in Aberdeen were expanded.

The Society also helped to establish surgical guidelines for neurosurgical conditions. For example, at the Michaelmas meeting in Manchester on 30 November 1934, Learmonth opened a discussion to consider the question 'Is the Society able to formulate guiding principles for declining to operate in certain cases of intracranial tumour'?[71] He suggested that the society should formulate some definitive guidelines regarding some cases of brain tumours that were not helped by operation. This led to a discussion from the delegates about which tumours should and should not be operated on, and the justification of their decision. Ultimately, this meant that these men could exchange their experiences and set standards for the practice of neurosurgical procedures, and apply them in their own institutions.

The role of the SBNS in establishing standards for procedures, advocating surgical styles and allowing the networking between these individuals with a unique set of skills, was of the utmost importance in the advancement of neurosurgery.

Conclusions

Despite there being no neurosurgical ward or specialist dedicated to neurosurgery prior to 1948, a wide range of neurosurgical procedures were undertaken in ARI between 1920 and 1940. They were initially carried out by general surgeons and later by those trained in the specialty. The procedures encompassed several neurosurgical parameters and included complex operations requiring a meticulous approach.

WWI proved to be a valuable learning experience for the Aberdonian surgeons serving in France. Exposure to the sheer volume of cranio-spinal injuries meant that Gray could establish the basic management principles for this trauma. It also meant that amongst the surgeons operating on cranio-spinal wounds, ideas could be shared, surgical techniques could be suggested and certain tools could be advocated. Thus, the knowledge and skills could be brought back to ARI and applied to the neurosurgical operations.

Neurosurgical practices in ARI was further aided by the availability of research publications and case studies from those operating on the nervous system. More specialist tools

and surgical approaches were being developed by the doyen of American neurosurgery, Cushing. His craft was brought back to Great Britain, disseminated and implemented in the institutions by the British surgeons who went to train under him. With Dott bringing back Cushing's techniques to Scotland, he provided the opportunity for the Aberdonian surgeons to acquire and practise this new neurosurgical style to integrate into their operations.

In 1933, the neurosurgical procedures grew and became more diverse in nature after the arrival of Sir James Learmonth to ARI. Learmonth dedicated parts of his ward to neurosurgical patients and recruited surgeons into his practice. The research Learmonth undertook and his training in North America with the innovators in the field meant that he could lead neurosurgery away from general surgery and establish it as a distinct speciality in ARI.

Specialist societies and institutions with pioneering surgical neurologists played a predominant role in setting standards and protocols for neurosurgical procedures and in the spreading of neurosurgical knowledge farther afield. Learmonth's involvement and networking within the SBNS enabled him to exchange and acquire the skills to lead neurosurgery in ARI and mark the institution as a centre at the forefront of neurosurgical activity.

Following Learmonth's departure in 1939, the need for a neurosurgical unit in ARI was recognised after neurosurgical patients were unable to obtain the treatment they required. This often resulted in the transfer to the cranial unit in Edinburgh, incurring large costs and presenting difficulty for patients. This led to the establishment of a dedicated neurosurgical unit in 1948 with Martin Nichols as the first full-time neurosurgeon. Thus, the contributions of Anderson and Learmonth towards establishing neurosurgical practices in ARI deserve full recognition.

Acknowledgements

We would like to thank Mr Thomas Scotland and Dr Ben Marsden for their advice, encouragement and help with the manuscript. We would also like to thank Fiona Musk, archivist at NHS Grampian, Mr Philip Van Hille, archivist at the Society of British Neurological Surgeons, and Hilary Hinton, librarian at Aberdeen Medico-Chirurgical Society, for helping us with our research.

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