

Review Article

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The early history and development of functional endoscopic sinus surgery

K J Kane

Abstract

Background. The concept of endoscopic diagnosis and procedures on the nasal cavity had been investigated for several decades in Europe in the early part of the twentieth century. It was Prof Walter Messerklinger and his assistant, Heinz Stammberger, with US colleague, David Kennedy, who brought the science and technique of functional endoscopic sinus surgery to the wider world.

Methods. The author, an English-speaking surgeon, was present at this movement from the commencement of its propagation, and has recorded the remarkable ascendancy of this technique throughout the world.

Conclusion. The technique revolutionised the diagnosis and management of intranasal, sinus and intracranial conditions.

Introduction

When functional endoscopic sinus surgery (FESS) burst upon the anglophone world in the mid-1980s, the concept was not new. The science had been investigated for decades by otolaryngologists with an interest in rhinology, particularly in German-speaking Europe.

According to Draf,¹ Reichert in 1902 and Hirschman and Valentin in 1903, produced modified endoscopes made by the firm Reiniger, Gabbert and Scholl of Berlin, based on the cystoscope designed by Nitze in 1897. These modified cystoscopes were used for endoscopic diagnosis, and the work was published in the German literature.^{2,3}

Discussion

In the history of the genesis and worldwide dissemination of FESS, three names stand out: Messerklinger, Stammberger and Kennedy. Their particular contributions are discussed below.

Prof Walter Messerklinger

Walter Messerklinger (4 March 1920–5 August 2001) ([Figure 1](#)), working in Graz in the Austrian state of Styria, performed the basic research and developed the surgical principles that would later become known as the Messerklinger technique of endoscopic sinus surgery.

From the 1950s and 1960s, Messerklinger, in his department, mapped the mucus transport routes in the nose on cadavers, whose cilia continued to beat for 48 hours after death, thus providing an excellent model for this type of research. Using Indian ink particles, he carefully noted that the maxillary sinus mucus flow was always towards the natural ostium, and then backwards through the middle meatus to the posterior nasal space. This basic research had also been performed by Hilding, and was reported in his papers in 1932⁴ and 1941.⁵ These observations explained the frequent failure of traditional gravitational surgical techniques such as inferior meatal antrostomies and Caldwell–Luc procedures. The essential issue was to clear and facilitate drainage towards the natural ostium.

In 1972, Messerklinger⁶ introduced the endoscope as a method of diagnosis and therapy. Messerklinger⁷ further described anatomical variants within the nose that could interfere with this mucus outflow; he listed them as a deviated uncinat process, a deviated nasal septum, a concha bullosa and a paradoxically bent middle turbinate cramping the middle meatal space. Some of this early work was discredited by later investigators.

Messerklinger, in the 1960s, initially using a modified cystoscope and operating under local anaesthesia, refined the technique of operating in a near-bloodless field. He developed the idea of performing surgery that was tailored to each individual, depending on the cause of the obstruction and what was required to establish normal ventilation of the sinuses. Thus, the surgery was minimalist in nature and concept.

Further, Messerklinger developed the theory that the major sinuses such as the frontal and maxillary sinuses were ‘dependant sinuses’, namely dependant on a clear anterior ethmoid cell structure in the middle meatus. This middle meatal zone, later termed ‘the



Fig. 1. Prof Walter Messerklinger (left) and his assistant at that time, Heinz Stammberger (right).

ostioameatal unit', was originally coined by Naumann⁸ and popularised by Kennedy (see below). Thus, as Stammberger noted in his book *Functional Endoscopic Sinus Surgery. The Messerklinger Technique*,⁹ the Messerklinger technique changed operations on the frontal sinus into operations on the frontal recess, and operations on the maxillary sinus into operations on the ethmoidal infundibulum.

In other European centres, various workers were developing similar concepts. Most prominent amongst them were Prof Malte Wigand from Erlangen¹⁰ and Wolfgang Draf in Fulda, Germany, and Pierre Rouvier from Arles, France. However, it was Messerklinger who emphasised that surgery should be directed towards providing clear drainage and ventilation via the natural ostia of the sinuses, and hence be 'functional'.

The advancement of FESS to English-speaking countries was hampered by the fact that Messerklinger did not speak English and delivered his lectures to European audiences in German, his native tongue. However, his photographic illustrations of the internal structures and pathology of the nose were revolutionary and revelatory to a young English-speaking audience member, David Kennedy, who attended his lecture in Dubrovnik in 1984. Messerklinger had had his book *Endoscopy of the Nose* published by Urban and Schwarzenberg in 1978 (Figure 2),⁷ and curiously this had attracted little interest and excitement in the English-speaking countries to which the book was directed.

Prof Heinz Stammberger

A major player in the unfolding and propagation of this technique was the late Prof Heinz Stammberger (1946–2018) (Figure 1). Amongst many fine qualities, Stammberger had the advantage of speaking English, which he had perfected while spending time in the USA. Stammberger's family were from Cologne in the Rhineland, and Heinz's father was a friend of Walter Messerklinger when they were Luftwaffe pilots in the Second World War.

Messerklinger's department was devastated by the Anschluss in 1938, after Austria was absorbed by Germany, when his department shrank from 35 members to 2 within six weeks. He spent the 1950s and 1960s slowly rebuilding the department and performing rhinological research. On graduating with his basic medical degree in Germany, Stammberger joined Messerklinger in Graz, Austria.

Stammberger eventually succeeded Messerklinger as Head of Rhinology in Graz. He had started his Residency in Graz

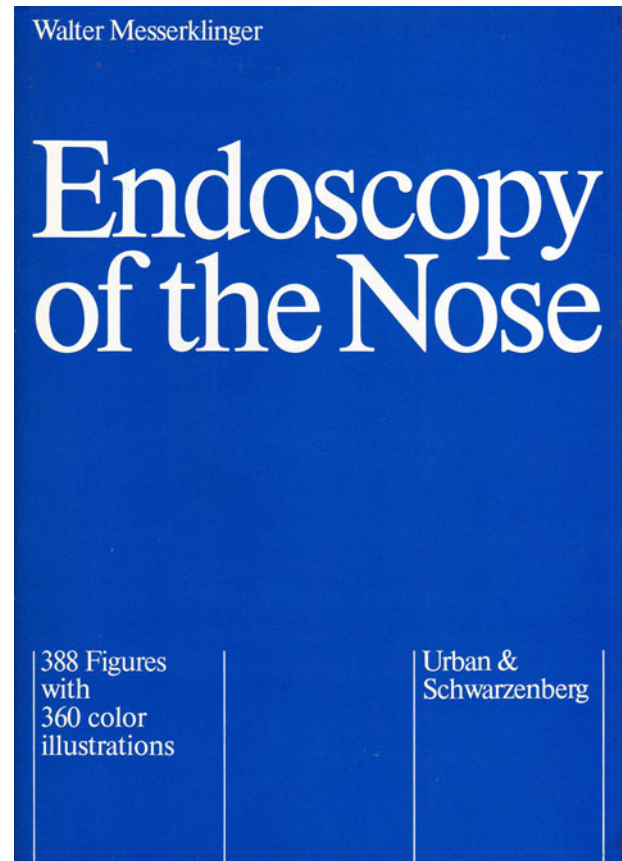


Fig. 2. *Endoscopy of the Nose*, by Prof Walter Messerklinger (1978).

in 1975 and had assisted Messerklinger in several hundred cases in the late 1970s, where his role was to hold Messerklinger's bulky and unwieldy camera attached to his prototype endoscope. Stammberger assisted Messerklinger in this photography for his manuscript on endoscopic diagnosis of the nose. It was finally ready to be placed with the publisher in 1975, but, as previously noted, attracted little interest at first. It was eventually published in English under the title *Endoscopy of the Nose*,⁷ as already mentioned.

In February 1986, Stammberger published in *The Journal of Otolaryngology – Head and Neck Surgery* his articles 'Endoscopic endonasal surgery – concepts in treatment of recurring rhinosinusitis. Part I. Anatomic and pathophysiological considerations'¹¹ and 'Endoscopic endonasal surgery – concepts in treatment of recurring rhinosinusitis. Part II. Surgical technique'.¹² In this latter article, the experience of the Graz department with 2500 endoscopic surgical cases was described, and the safety of the technique was stressed.

These papers were later to set off a fire storm in the English-speaking rhinological world. Interestingly, however, when Heinz Stammberger spoke the following year in July 1987 at the 7th British Academic Conference in Otolaryngology in Glasgow, UK, his lecture in a small side room of the conference centre was only attended by a dozen or so delegates. Most otolaryngologists remained unmoved and sceptical of the rumours of this new type of surgery.

Stammberger commenced endoscopic sinus courses in Graz in 1986 and these became a drawcard for rhinologists from all over the world. He participated in hundreds of conferences, courses and seminars in many countries, and published voluminous papers on the subject. He was a tireless worker for the expansion and acceptance of this technique.

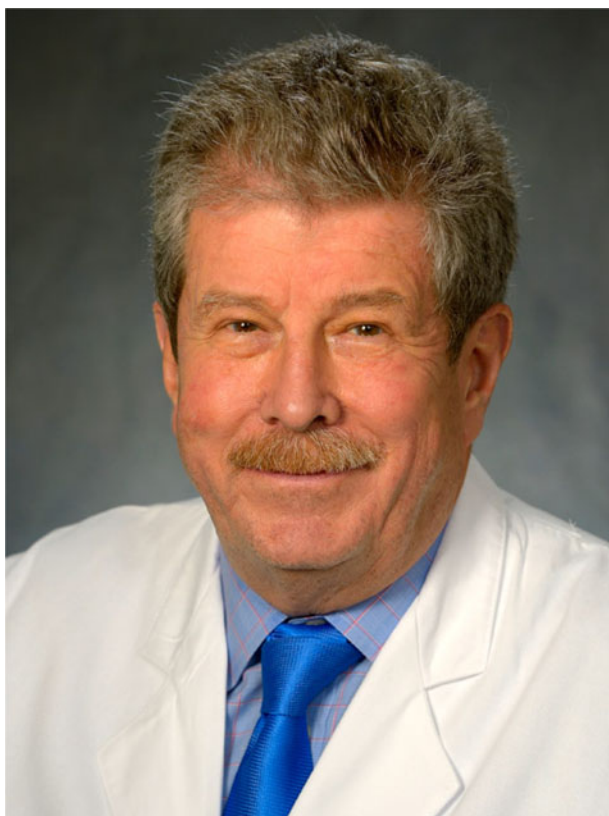


Fig. 3. Prof David Kennedy.

Prof David Kennedy

David Kennedy (Figure 3) was the other major player in the development, teaching and promulgation of endoscope sinus surgery. He gained his medical education in the UK and then took up a Residency Program in Surgery at the Johns Hopkins University in Baltimore in 1973–74. He became a Resident in Otolaryngology at the same institution between 1974 and 1978.

In the late 1970s, David Kennedy reviewed a copy of Messerklinger's book, *Endoscopy of the Nose*,⁷ for his hospital department at Johns Hopkins University, and immediately realised the importance of this new surgical development. He attended a lecture that Messerklinger delivered in Dubrovnik in 1984 and approached Messerklinger with a request to spend time in his department in Graz. This was granted in 1985 and following that the excited young resident, realising the full impact of what he had witnessed and been taught, returned to Baltimore.

In 1985, Kennedy approached Michael Johns, the Department Chairman at Johns Hopkins University, with the idea of establishing a Department of Endoscopic Sinus Surgery. The department at Johns Hopkins had a long history in sinus physiology through the basic research and interest of fellow faculty member, Dr Don Proctor, so they were enthusiastic in their response. Kennedy went on to acquire the skills and knowledge required in the university's Anatomy Department, and from there became a major force in the development, teaching and dissemination of this technique.

Kennedy moved from Johns Hopkins University to become Professor and Chairman of Otolaryngology at the University of Pennsylvania. Here, he developed an outstanding teaching faculty with such members as Drs Don Lanza and Bill

Bolger, pioneered and developed endoscopic surgical instrumentation, and extended the surgery to new surgical areas. He ran numerous teaching courses and faculties around the world with his enormous energy and masterful lecturing skills. As Editor, he expanded, with Dr Guy Settipane, the renowned rhinology journal, *The American Journal of Rhinology*, enabling it to become a leading publication of new concepts and developments in the field.

In 1985, after returning to his department at Johns Hopkins University, Kennedy published seminal articles on endoscopic sinus management, which had a major impact on the English-speaking world, particularly the USA. Kennedy's articles appeared in the *Archives of Otolaryngology* in September 1985 under the title, 'Functional endoscopic sinus surgery. Theory and diagnostic evaluation',¹³ and in October 1985 in the same journal under the title, 'Functional endoscopic sinus surgery. Technique'.¹⁴ It was Kennedy who popularised the term 'functional endoscopic sinus surgery', which, despite criticism, has stood the test of time.

At the same time in Germany, alternative endoscopic schools were developing their own techniques. Wolfgang Draf in Fulda utilised a combination of rigid endoscopes and the operating microscope to drill out the frontal sinus in recalcitrant cases. Malte Wigand in Erlangen introduced an alternative parallel school of endoscopic surgical concepts or functional compartment surgery, utilising wider surgical resection. He used both headlight and suction endoscopy in a gun-like instrument with a handle arrangement, opening up the sphenoid first and then performing a retrograde resection from posterior to anterior. Disease was pursued and removed, rather than left to resolve spontaneously, unlike the Messerklinger drainage and ventilation system.

Functional endoscopic sinus surgery was taken up and promoted in various countries, particularly by Drs Ian Mackay and Valerie Lund in the UK, Michael Hawke in Canada, and Kevin Kane and later PJ Wormald in Australia.

Early technological advances

Three technological developments were significant in the early development of FESS.

The first was HH Hopkins's development of telescopes with greatly improved optics. These were miniaturised and could be readily inserted into the nasal cavity.

Prof Harold Hopkins held the Chair in Optics at Reading University, UK, and developed a rigid rod lens system of telescopes between 1951 and 1956, which was patented in 1959. In 1967, Karl Storz in Tübingen, Germany, bought the patent, and began to produce endoscopes with fine imaging, superb illumination and perfect fidelity of colour. At the same time, brilliant fibre-optic light sources were produced, separate from the endoscope.

Prof Hopkins made a short speech about his inventions at the Combined 9th International Society of Inflammation and Allergy of the Nose and the 13th European Rhinologic Society meeting, 24–29 June 1990, in London. The meeting was chaired by Prof David Brain for the European Rhinologic Society and by Mr Ian Mackay for the International Society of Inflammation and Allergy of the Nose, both of the UK.

The endoscopes were 4 mm in diameter and 10 cm in length. As well as a 0° lens, they were available with 30° and 70° lenses. Later, in 2000, 45° and 120° lenses were added. Initially, the 30° lens was used for diagnosis and the majority of the surgical technique. This surgical technique required

firstly that an infundibulotomy be performed utilising a small sickle knife, and the ethmoidal infundibulum entered. The uncinat process, which formed the medial wall of the infundibulum, was then removed, thus opening up the natural ostium and the drainage zone of the maxillary sinus. This concept was completely new to the English and US concept of sinus anatomy and surgical drainage, as this anatomy was not described in traditional English texts such as *Grey's Anatomy*.

The second major impetus in the development of this new surgery was the advent of new detailed radiological imaging.

In the late 1970s, Messerklinger and Stammberger pioneered the use of hypocycloidal polytomograms to define the intricate morphology of the sinus system. Coronal and sagittal plane imaging at 5 mm intervals was used. Although this imaging was a vast improvement over traditional plane sinus X-rays, the finer anatomical detail of the ostiomeatal unit was blurred and indistinct, so their usefulness was somewhat limited.

The advent of computed tomography (CT) scanning gave an enormous advancement to the diagnosis and management of sinus pathology, and the surgical correction required. Computed tomography scanning was said to provide a 'road map' to unlock the complex anatomy of the ethmoid sinus cell system and its dependant sinuses.

The CT scan was originally called the EMI scan because the first commercial scanner was developed by Sir Godfrey Hounsfield, a scientist with EMI, the English electronic company located in Hayes, west of London, in the early 1970s. The first EMI scanners were installed in the Atkinson Morley Hospital in Wimbledon, London, and in the Manchester Royal Infirmary in 1973, under the supervision of the Director of Neuroradiology, Dr Ian Isherwood. Initially, the technique was performed in the axial plane. When other companies started to produce scanners, it became known as computerised axial tomography ('CAT') scanning.

In the USA, Prof David Kennedy teamed up with his radiological colleague, Dr S James Zinreich, with the Radiology Department of Johns Hopkins University School of Medicine at Baltimore, and developed and refined techniques to image the paranasal sinuses and ostiomeatal complex. In place of 5 mm axial cuts, 2 mm and 3 mm coronal cuts were reconstructed through the ostiomeatal unit, and then 5 mm cuts to the sphenoid. This greatly improved its capabilities in diagnosing pathology and enhanced the anatomical detail of the ethmoid complex.

Zinreich later became part of a teaching faculty with Stammberger, Kennedy, G Wolf and others, and he became a major force in the worldwide dissemination of this technique. Later, when magnetic resonance imaging became available with its superior soft-tissue resolution, Zinreich pioneered its role in otolaryngology. However, CT scanning remains the predominant technique because of its better ability to define bone.

The third advancement was the miniaturisation of cameras. At the same time that the miniaturisation of telescopes was being developed, a technical revolution was occurring with the miniaturisation of cameras. These attached to the eyepiece of the telescope and allowed assisting nurses to participate easily in the surgical procedure. It also allowed the surgery to be viewed by trainee surgeons directly off the monitor in the operating theatre, or to be projected to an auditorium where hundreds of delegates could observe.

The original cameras were produced by Storz, Richards and Xomed in one-, two- and three-chip models. The early

cameras were heavy and bulky. Beam-splitters were introduced so that the surgeon could operate directly down the telescope, with the side-attached camera providing an image for the assistant or watching gallery. The beam-splitter required a high-powered light source, which was available through the improved fibre-optic lighting systems. The initial light systems were light-emitting diodes and halogen, and later high-powered Xenon systems were introduced.

The advent of an acute-angled beam-splitter rather than a right-angled model allowed the weight of the camera to rest on the back of the surgeon's hand, thus facilitating its use. The surgeon rested his arm or elbow on a support to take the full weight, and this proved ergonomically optimal. Xomed produced a chair with an adjustable side arm that was widely used for this purpose. Later, surgeons such as their orthopaedic and urological colleagues began operating directly off the monitor screen, without using a beam-splitter. Prof Frederick Kuhn from Savannah, Georgia, USA, was one of the first to popularise this technique utilising a three-chip camera.

Early refinements

The late 1980s and 1990s ushered in a rapid expansion of understanding and solving of problems that the new technique had spawned.

In a seminal paper, Bent, Cuijly-Siller and Kuhn¹⁵ unfolded the complex anatomy of the frontal sinus and its associated frontal ethmoid cell structure. Draf,¹⁶ and later May¹⁷ in Pittsburgh, Philadelphia, pioneered endoscopic surgical approaches to the frontal sinus. The medical technology company Medtronic introduced MeroGel® containing hyaluronic acid, which did much to solve the difficult and frustrating problem of middle meatal adhesions. Other biocompatible materials followed.

In the 1990s, Moriyama *et al.*,¹⁸ of the Jikei University of Medicine in Tokyo, showed the importance of mucosal preservation in sinus surgery, and this initiated a new generation of mucosal-sparing forceps called 'Throughcut' or 'Trucut' instruments. These were later superseded by the advent of mechanical power-driven, suction-based shavers, initially promoted by Setliff and Parsons¹⁹ in the USA.

Anaesthesia

Anaesthesia for FESS also evolved over these early years. Initially, the recommendation was that endoscopic surgery be performed under local anaesthesia with sedation. This was purported to give a more bloodless operating field and thus better visualisation. The awake patient could also experience pain once pain-sensitive areas such as the fovea and orbit were approached, and direct feedback clues could be given to the operating surgeon to alert him of imminent danger. Both Kennedy and Stammberger advocated the use of local anaesthesia in the 1980s and 1990s.

However, modern anaesthetic agents without the use of halothane and other vasodilating agents outdated this concept, and the majority of surgeons later began operating under general anaesthesia.

Extended applications

The advent of FESS pushed the boundaries of otolaryngology into areas that were formerly the preserve of ophthalmologists and neurosurgeons. There was renewed interest in intranasal

dacryocystorhinostomy, and intranasal endoscopic orbital decompression was described, as well as optic nerve decompression in the optic canal at the base of the orbit. In the early 1990s, several surgical schools began utilising the nasal endoscopes for pituitary surgery. The successes of these techniques opened the door to the advent of endoscopic intranasal skull base surgery.

The move into skull base surgery was aided by the development of computer-guided surgical systems pioneered at the University of Aachen, Germany, by Schlöndorff *et al.*,²⁰ and was further evolved by Zinreich and colleagues²¹ with the introduction of the image-guided neurosurgery system. Other systems rapidly followed.

Complications

Complications arising from FESS have been remarkably few, particularly as it required considerable retraining of otolaryngologists to cross over from traditional intranasal training to the new endoscopic techniques.

Stammberger reported the Graz experience of 2500 cases in February 1986,¹² as already mentioned, with no serious complications. Blood losses were minimal, with no patients requiring transfusion; none of the patients suffered injury to the ethmoid roof or dura, and there was no serious orbital injury.

The following year, in 1987, Stankiewicz²² reported a complication rate of 29 per cent in his first 90 patients, of which 8 per cent were major complications, including cerebrospinal fluid leaks and ocular mishaps. This rate was reduced to 2.2 per cent in the second 90 patients, as reported in the paper published in 1989.²³

This high complication rate was not the experience of most practising endoscopic sinus surgeons. Thus, in 1992, Kane²⁴ instituted a national survey in Australia of 100 practicing endoscopic sinus surgeons and the results were published 1993. Data for 10 000 cases were collected, with a complication rate of 0.22 per cent reported. In 1994, Mackay and colleagues²⁵ carried out a similar survey in the UK and found similar results.

Rhinological societies and conferences

In the decade after 1985, many major national congresses and symposia were held to propagate this new surgery. These were assisted by the formation of major rhinological societies in the 1950s and 1960s, particularly the American Rhinologic Society in 1954, the Japanese Rhinologic Society in 1962, the European Rhinology Society in 1964, and the overarching International Rhinologic Society²⁶ in 1965.

In 1992, from 29 July to 1 August, the 1st International Advanced Course in Functional Endoscopic Sinus Surgery was held in Vienna, Austria, under the direction of Heinz Stammberger. In 1993, the 2nd International Advanced Sinus Symposium took place in Philadelphia (Figure 4), under the direction of David Kennedy. The 3rd International Advanced Sinus Symposium followed in 1995, in Cairns, Australia, under the direction of Kevin Kane.

Conclusion

Today, the Messerklinger technique of FESS has become firmly established as the appropriate surgical treatment of inflammatory sinus disease. The expansion of the endoscope into other sinus areas and in skull base surgery has been

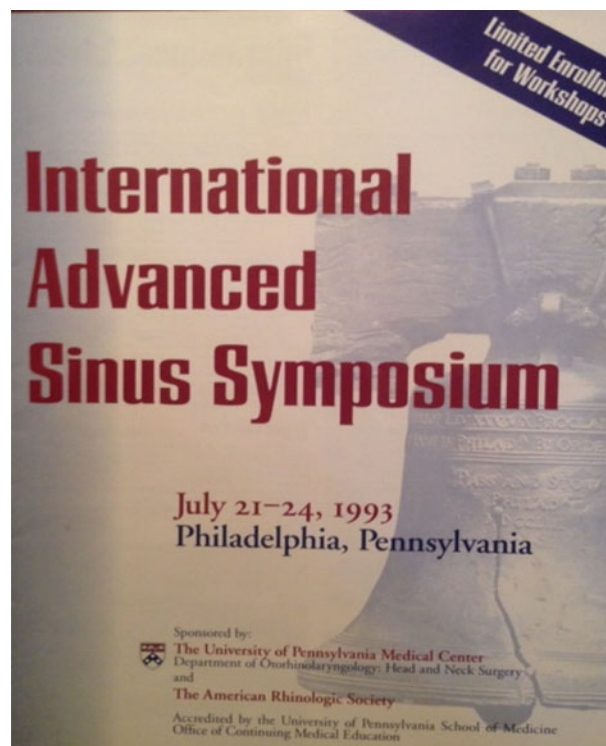


Fig. 4. The 2nd International Advanced Sinus Symposium, held in Philadelphia in 1993, under the direction of Prof David Kennedy.

one of the most exciting advances in our specialty in the latter half of the twentieth century. The legacy of the pioneers of this development will be enduring and appreciated.

Competing interests

None declared

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