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A Quantitative Analysis of Published Skull Base Endoscopy Literature

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Abstract

Objectives Skull base endoscopy allows for minimal access approaches to the sinonasal contents and cranial base. Advances in endoscopic technique and applications have been published rapidly in recent decades.

Setting We utilized an Internet-based scholarly database (Web of Science, Thomson Reuters) to query broad-based phrases regarding skull base endoscopy literature.

Participants All skull base endoscopy publications.

Main Outcome Measures Standard bibliometrics outcomes.

Results We identified 4,082 relevant skull base endoscopy English-language articles published between 1973 and 2014. The 50 top-cited publications ($n = 51$, due to articles with equal citation counts) ranged in citation count from 397 to 88. Most of the articles were clinical case series or technique descriptions. Most (96% [49/51])were published in journals specific to either neurosurgery or otolaryngology.

Conclusions A relatively small number of institutions and individuals have published a large amount of the literature. Most of the publications consisted of case series and technical advances, with a lack of randomized trials.

Keywords
- citation classic
- endonasal surgery
- endoscopy
- scholarly impact

Introduction

Neurosurgical endoscopy has expanded the armamentarium for treatment of skull base lesions in the modern neurosurgical era. Fully endoscopic endonasal approaches to skull base pathology have been explored as alternatives to the traditional craniotomy or microsurgical transsphenoidal approach. Endoscopy has been combined with traditional microneurosurgical approaches to assist in the treatment of skull base lesions such as those within the cerebellopontine angle. The growing interest in clinical skull base neuroendoscopy is reflected in the increasing number of pertinent peer-reviewed publications of clinical patient series, technical advances in skull base endoscopy, and laboratory-based analyses of endoscopic technique, among other topics.

In medical bibliometrics, the term *citation classic* has been proposed to identify those publications that have the most impact on a given field.[1] Many authors have used a cutoff of 400 postpublication citations of an article to yield a citation classic, although this number is arbitrary.[1–5] Endoscopic skull base surgery is a young subspecialty with a relatively narrow clinical focus. We sought to identify the top-cited works in this field. The identification of such publications allows authors to assess their own scholarly impact on their specialty and to better understand the topics most broadly applicable to a field. These and other metrics, such as the h-index, may also be used to assess the impact of an institution on a specialty.[6] Lastly, these highly cited papers may also form a core syllabus for trainees. Previously, we and other groups analyzed the citation classics and other highly cited works in neurosurgery as a whole, as well as in subspecialty areas such as Parkinson disease, depression, stereotactic and functional neurosurgery, and epilepsy.[7–12]

Methods

We used a widely available online scholarly database (Web of Science, Thomson Reuters) to query multiple broad-based

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Table 1 Search terms for Web of Science data acquisition

Search terms[a]
Endoscopic adenoma
Endoscopic cerebrospinal fluid leak
Endoscopic chordoma
Endoscopic cranial base
Endoscopic craniopharyngioma
Endoscopic endonasal
Endoscopic meningioma
Endoscopic meningitis
Endoscopic neurosurgery
Endoscopic neurosurgical technique
Endoscopic skull base
Endoscopic skull base repair
Endoscopic transsphenoidal
Endoscopy complication
Expanded endoscopic endonasal
Intracranial endoscopy

[a]For all search terms, both "endoscopic" and "endoscopy" were used (not shown for brevity).

predetermined phrases regarding skull base endoscopy (►**Table 1**). All databases within Web of Science were queried for English-language articles using these search terms. We searched across journal-based publications only and did not query book chapters, meeting abstracts, or patents. We then manually verified the relevance of these results to the field and identified the 50 articles with the most citations since publication. Articles exclusive to supratentorial (e.g., intrinsic brain tumors), intraventricular (e.g., third ventriculostomy, colloid cyst), or spinal endoscopy were manually excluded, as were articles solely dedicated to the anesthetic concerns of endoscopic surgery. Endoscopic dacryocystorhinostomy articles were excluded; however, otolaryngology articles regarding endoscopic sinus surgery and endonasal approaches relevant to skull base approaches were included. To check for omissions that may have resulted from our limited search criteria, we queried the open-ended phrase "endoscop*" across all journals in which the top-50 article was published; no additional results were found. Institutional attribution was assigned based on the affiliation of the first author at the time of publication.

Results

Literature Database Search

Our search identified 4,082 relevant skull base endoscopy English-language articles published between 1973 and August 2014. Total citations for published articles varied between zero and 397 citations after publication.

Overall Literature Trends

The overall number of skull base endoscopy articles published per year has risen dramatically over the last 40 years, with a marked jump seen over the last decade (►**Fig. 1**). Less than 30 articles per year were published between years 1973 and 1993, whereas over the past 3 years (2011–2013, inclusive) there has been > 400 individual articles published per year. Of the 4,082 total articles identified, 13% ($n = 517$) were published in year 2013 alone. Articles published ≥ 1 year prior to analysis ($n = 3{,}563$) were cited a median of 6 times after publication, or 0.8 times per year; 549 (15%) had zero postpublication citations. Of articles published ≥ 2 years prior to analysis, 322 (10%) had zero postpublication citations.

Top 50 Most-Cited Articles

The "top 50" articles ($n = 51$, due to articles with equal citation counts) ranged in postpublication citation count from 397 to 88, and they were published between 1986 and 2009 (►**Table 2**; ►**Fig. 2**). The most-cited publication also had the highest rate of citations per year. Overall, 51% of the most-cited articles were produced from two institutions (►**Table 3**). Most of the top articles were clinical case series (37%), followed by descriptions of novel skull base endoscopy techniques (24%), intraoperative and/or cadaver-based anatomy (12%), endoscopic-related complications (10%), review articles of established techniques (10%), novel technologies applied to endoscopy (4%), and meta-analyses (4%) (►**Table 4**). The clinical case series ranged in patients included from 5 to 2,108, with a median number of 100 patients per series. The four largest of the case series (articles ranked 5, 18, 21, and 35) were from the otolaryngology literature regarding sinonasal pathophysiology, anatomy, and surgical approaches. Almost all top articles were published in journals specific to either neurosurgery or otolaryngology (96%; ►**Table 5**), with the most number of articles published in *Neurosurgery* ($n = 13$) followed by *Laryngoscope* ($n = 12$). We identified no economic studies, randomized controlled clinical trials, or patient quality-of-life studies among the top-50 most-cited publications.

Discussion

Medical bibliometrics allows for the quantitative study of published scholarly activity within a certain subspecialty. We examined the literature of the relatively young field of endoscopic skull base surgery. Our goals were to assess the literature as a whole and then identify the most-cited publications within skull base endoscopy.

The acceleration in publications per year within skull base endoscopy is noteworthy. Although we searched for all articles from 1973 onward, roughly a third (32%) were published in the most recent 3 full years examined (2011–2013). From the year 2000 onward, article publication has increased by an average of 14% per year. This expanse in publications per year is due to multiple factors, and it reflects the general recent interest in skull base endoscopy within neurosurgery and otolaryngology as well as the addition of subspecialty-specific journals. The median article was cited 6 times, or 0.8 times per year since publication, and this number can serve as a benchmark to authors to measure their own impact within the field.

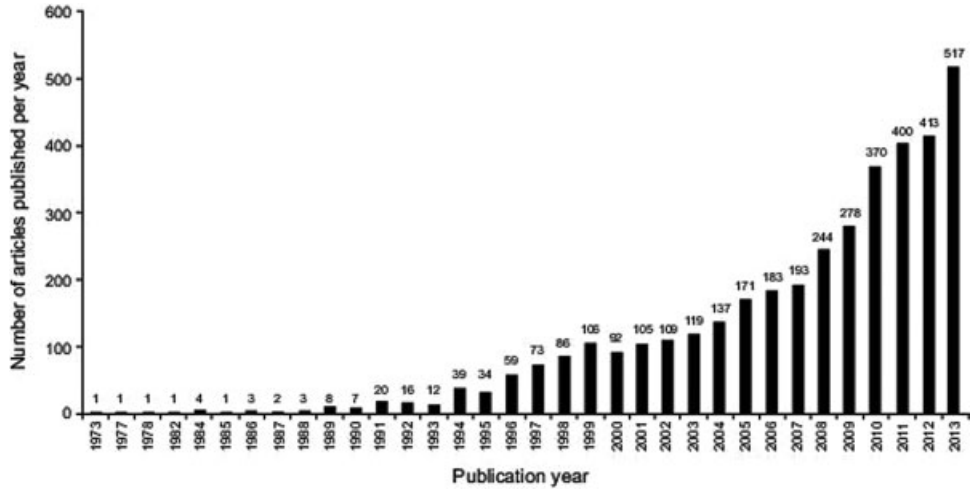

Fig. 1 Total number ($n = 3,808$) of skull base endoscopy articles (y-axis) published per year (x-axis) between 1973 and 2013 (excludes the 274 articles published between January and August 2014).

Table 2 Top skull base endoscopy articles ($n = 51$ including ties) by number of citations

Rank	Citations (citations per year)	Publication
1	397 (44.1)	Hadad G, Bassagasteguy L, Carrau RL, Mataza JC, Kassam A, Snyderman CH, Mintz A. A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. Laryngoscope. 2006 Oct;116(10):1882–6.
2	370 (12.8)	Stammberger H. Endoscopic endonasal surgery–concepts in treatment of recurring rhinosinusitis. Part I. Anatomic and pathophysiologic considerations. Otolaryngol Head Neck Surg. 1986 Feb;94(2):143–7.
3	348 (19.3)	Jho HD, Carrau RL. Endoscopic endonasal transsphenoidal surgery: experience with 50 patients. J Neurosurg. 1997 Jul;87(1):44–51.
4	276 (9.5)	Stammberger H. Endoscopic endonasal surgery—concepts in treatment of recurring rhinosinusitis. Part II. Surgical technique. Otolaryngol Head Neck Surg. 1986 Feb;94(2):147–56.
5	243 (9.7)	Stammberger H, Posawetz W. Functional endoscopic sinus surgery. Concept, indications and results of the Messerklinger technique. Eur Arch Otorhinolaryngol. 1990;247(2):63–76.
6	235 (13.8)	Perneczky A, Fries G. Endoscope-assisted brain surgery: part 1–evolution, basic concept, and current technique. Neurosurgery. 1998 Feb;42(2):219–24; discussion 224–5.
7	222 (22.2)	Kassam A, Snyderman CH, Mintz A, Gardner P, Carrau RL. Expanded endonasal approach: the rostrocaudal axis. Part I. Crista galli to the sella turcica. Neurosurg Focus. 2005 Jul 15;19(1):E3.
8	222 (22.2)	Kassam AB, Gardner P, Snyderman C, Mintz A, Carrau R. Expanded endonasal approach: fully endoscopic, completely transnasal approach to the middle third of the clivus, petrous bone, middle cranial fossa, and infratemporal fossa. Neurosurg Focus. 2005 Jul 15;19(1):E6.
9	198 (13.2)	Hegazy HM, Carrau RL, Snyderman CH, Kassam A, Zweig J. Transnasal endoscopic repair of cerebrospinal fluid rhinorrhea: a meta-analysis. Laryngoscope. 2000 Jul;110(7):1166–72.
10	190 (14.6)	Cappabianca P, Cavallo LM, Colao A, de Divitiis E. Surgical complications associated with the endoscopic endonasal transsphenoidal approach for pituitary adenomas. J Neurosurg. 2002 Aug;97(2):293–8.
11	186 (18.6)	Kassam A, Snyderman CH, Mintz A, Gardner P, Carrau RL. Expanded endonasal approach: the rostrocaudal axis. Part II. Posterior clinoids to the foramen magnum. Neurosurg Focus. 2005 Jul 15;19(1):E4.
12	178 (11.1)	Gumprecht HK, Widenka DC, Lumenta CB. BrainLab VectorVision Neuronavigation System: technology and clinical experiences in 131 cases. Neurosurgery. 1999 Jan;44(1):97–104; discussion 104–5.
13	176 (10.4)	Cappabianca P, Alfieri A, de Divitiis E. Endoscopic endonasal transsphenoidal approach to the sella: toward functional endoscopic pituitary surgery (FEPS). Minim Invasive Neurosurg. 1998 Jun;41(2):66–73.

Table 2 (*Continued*)

Rank	Citations (citations per year)	Publication
14	176 (7.0)	Mattox DE, Kennedy DW. Endoscopic management of cerebrospinal fluid leaks and cephaloceles. Laryngoscope. 1990 Aug;100(8):857–62.
15	172 (9.0)	Lanza DC, O'Brien DA, Kennedy DW. Endoscopic repair of cerebrospinal fluid fistulae and encephaloceles. Laryngoscope. 1996 Sep;106(9 Pt 1):1119–25.
16	169 (9.9)	Fries G, Perneczky A. Endoscope-assisted brain surgery: part 2—analysis of 380 procedures. Neurosurgery. 1998 Feb;42(2):226–31; discussion 231–2.
17	163 (14.8)	Cappabianca P, Cavallo LM, de Divitiis E. Endoscopic endonasal transsphenoidal surgery. Neurosurgery. 2004 Oct;55(4):933–40; discussion 940–1.
18	163 (8.6)	Teo P, Yu P, Lee WY, Leung SF, Kwan WH, Yu KH, Choi P, Johnson PJ. Significant prognosticators after primary radiotherapy in 903 nondisseminated nasopharyngeal carcinoma evaluated by computer tomography. Int J Radiat Oncol Biol Phys. 1996 Sep 1;36(2):291–304.
19	160 (6.2)	Stankiewicz JA. Complications in endoscopic intranasal ethmoidectomy: an update. Laryngoscope. 1989 Jul;99(7 Pt 1):686–90.
20	157 (13.0)	Zada G, Kelly DF, Cohan P, Wang C, Swerdloff R. Endonasal transsphenoidal approach for pituitary adenomas and other sellar lesions: an assessment of efficacy, safety, and patient impressions. J Neurosurg. 2003 Feb;98(2):350–8.
21	157 (7.5)	May M, Levine HL, Mester SJ, Schaitkin B. Complications of endoscopic sinus surgery: analysis of 2108 patients–incidence and prevention. Laryngoscope. 1994 Sep;104(9):1080–3.
22	156 (12.0)	Cappabianca P, Cavallo LM, Colao A, Del Basso De Caro M, Esposito F, Cirillo S, Lombardi G, de Divitiis E. Endoscopic endonasal transsphenoidal approach: outcome analysis of 100 consecutive procedures. Minim Invasive Neurosurg. 2002 Dec;45(4):193–200.
23	155 (19.4)	Laufer I, Anand VK, Schwartz TH. Endoscopic, endonasal extended transsphenoidal, transplanum transtuberculum approach for resection of suprasellar lesions. J Neurosurg. 2007 Mar;106(3):400–6.
24	155 (8.2)	Carrau RL, Jho HD, Ko Y. Transnasal-transsphenoidal endoscopic surgery of the pituitary gland. Laryngoscope. 1996 Jul;106(7):914–8.
25	153 (11.8)	de Divitiis E, Cappabianca P, Cavallo LM. Endoscopic transsphenoidal approach: adaptability of the procedure to different sellar lesions. Neurosurgery. 2002 Sep;51(3):699–705; discussion 705–7.
26	146 (10.4)	Kaptain GJ, Vincent DA, Sheehan JP, Laws ER Jr. Transsphenoidal approaches for the extracapsular resection of midline suprasellar and anterior cranial base lesions. Neurosurgery. 2001 Jul;49(1):94–100; discussion 100–1.
27	140 (8.2)	Hopf NJ, Perneczky A. Endoscopic neurosurgery and endoscope-assisted microneurosurgery for the treatment of intracranial cysts. Neurosurgery. 1998 Dec;43(6):1330–6; discussion 1336–7.
28	138 (9.9)	Jho HD. Endoscopic transsphenoidal surgery. J Neurooncol. 2001 Sep;54(2):187–95.
29	133 (19.0)	Gardner PA, Kassam AB, Thomas A, Snyderman CH, Carrau RL, Mintz AH, Prevedello DM. Endoscopic endonasal resection of anterior cranial base meningiomas. Neurosurgery. 2008 Jul;63(1):36–52; discussion 52–4.
30	127 (12.7)	Kassam A, Carrau RL, Snyderman CH, Gardner P, Mintz A. Evolution of reconstructive techniques following endoscopic expanded endonasal approaches. Neurosurg Focus. 2005 Jul 15;19(1):E8.
31	126 (18.0)	Kassam AB, Thomas A, Carrau RL, Snyderman CH, Vescan A, Prevedello D, Mintz A, Gardner P. Endoscopic reconstruction of the cranial base using a pedicled nasoseptal flap. Neurosurgery. 2008 Jul;63(1 Suppl 1):ONS44–52; discussion ONS52–3.
32	125 (15.6)	de Divitiis E, Cavallo LM, Cappabianca P, Esposito F. Extended endoscopic endonasal transsphenoidal approach for the removal of suprasellar tumors: Part 2. Neurosurgery. 2007 Jan;60(1):46–58; discussion 58–9.
33	124 (6.9)	Jho HD, Carrau RL, Ko Y, Daly MA. Endoscopic pituitary surgery: an early experience. Surg Neurol. 1997 Mar;47(3):213–22; discussion 222–3.
34	108 (15.4)	Dehdashti AR, Ganna A, Karabatsou K, Gentili F. Pure endoscopic endonasal approach for pituitary adenomas: early surgical results in 200 patients and comparison with previous microsurgical series. Neurosurgery. 2008 May;62(5):1006–15; discussion 1015–7.

(*Continued*)

Table 2 (*Continued*)

Rank	Citations (citations per year)	Publication
35	106 (7.6)	Weber R, Draf W, Kratzsch B, Hosemann W, Schaefer SD. Modern concepts of frontal sinus surgery. Laryngoscope. 2001 Jan;111(1):137–46.
36	101 (14.4)	Schwartz TH, Fraser JF, Brown S, Tabaee A, Kacker A, Anand VK. Endoscopic cranial base surgery: classification of operative approaches. Neurosurgery. 2008 May;62(5):991–1002; discussion 1002–5.
37	101 (7.2)	Jackson MR. Fibrin sealants in surgical practice: An overview. Am J Surg. 2001 Aug;182(2 Suppl):1S-7S.
38	100 (14.3)	Nicolai P, Battaglia P, Bignami M, Bolzoni Villaret A, Delù G, Khrais T, Lombardi D, Castelnuovo P. Endoscopic surgery for malignant tumors of the sinonasal tract and adjacent skull base: a 10-year experience. Am J Rhinol. 2008 May-Jun;22(3):308–16.
39	98 (6.5)	Zweig JL, Carrau RL, Celin SE, Schaitkin BM, Pollice PA, Snyderman CH, Kassam A, Hegazy H. Endoscopic repair of cerebrospinal fluid leaks to the sinonasal tract: predictors of success. Otolaryngol Head Neck Surg. 2000 Sep;123(3):195–201.
40	97 (16.2)	Tabaee A, Anand VK, Barrón Y, Hiltzik DH, Brown SM, Kacker A, Mazumdar M, Schwartz TH. Endoscopic pituitary surgery: a systematic review and meta-analysis. J Neurosurg. 2009 Sep;111(3):545–54.
41	97 (12.1)	Fortes FS, Carrau RL, Snyderman CH, Prevedello D, Vescan A, Mintz A, Gardner P, Kassam AB. The posterior pedicle inferior turbinate flap: a new vascularized flap for skull base reconstruction. Laryngoscope. 2007 Aug;117(8):1329–32.
42	97 (9.7)	Cavallo LM, Messina A, Cappabianca P, Esposito F, de Divitiis E, Gardner P, Tschabitscher M. Endoscopic endonasal surgery of the midline skull base: anatomical study and clinical considerations. Neurosurg Focus. 2005 Jul 15;19(1):E2.
43	97 (8.8)	Jho HD, Ha HG. Endoscopic endonasal skull base surgery: Part 1–The midline anterior fossa skull base. Minim Invasive Neurosurg. 2004 Feb;47(1):1–8.
44	97 (4.0)	Stankiewicz JA. Cerebrospinal fluid fistula and endoscopic sinus surgery. Laryngoscope. 1991 Mar;101(3):250–6.
45	95 (4.0)	Maniglia AJ. Fatal and other major complications of endoscopic sinus surgery. Laryngoscope. 1991 Apr;101(4 Pt 1):349–54.
46	92 (15.3)	Stippler M, Gardner PA, Snyderman CH, Carrau RL, Prevedello DM, Kassam AB. Endoscopic endonasal approach for clival chordomas. Neurosurgery. 2009 Feb;64(2):268–77; discussion 277–8.
47	90 (6.4)	Jho HD, Alfieri A. Endoscopic endonasal pituitary surgery: evolution of surgical technique and equipment in 150 operations. Minim Invasive Neurosurg. 2001 Mar;44(1):1–12.
48	88 (12.6)	Cappabianca P, Cavallo LM, Esposito F, De Divitiis O, Messina A, De Divitiis E. Extended endoscopic endonasal approach to the midline skull base: the evolving role of transsphenoidal surgery. Adv Tech Stand Neurosurg. 2008;33:151–99.
49	88 (4.9)	Chambers DW, Davis WE, Cook PR, Nishioka GJ, Rudman DT. Long-term outcome analysis of functional endoscopic sinus surgery: correlation of symptoms with endoscopic examination findings and potential prognostic variables. Laryngoscope. 1997 Apr;107(4):504–10.
50	88 (4.6)	Jho HD, Carrau RL. Endoscopy assisted transsphenoidal surgery for pituitary adenoma. Technical note. Acta Neurochir (Wien). 1996;138(12):1416–25.
51	88 (3.8)	Vleming M, Middelweerd RJ, de Vries N. Complications of endoscopic sinus surgery. Arch Otolaryngol Head Neck Surg. 1992 Jun;118(6):617–23.

We have identified the top 50 most-cited articles within endoscopic skull base surgery. These publications encompass a wide variety of authors, institutions, journals, and topics. However, several trends among these top publications are obvious and deserve further mention. Two institutions in particular have made a significant contribution to the field. The University of Pittsburgh Medical Center (Pittsburgh, Pennsylvania, United States) and University Hospital, University of Naples Federico II (Naples, Italy) have produced over half of the top 50 publications identified. These institutions, via current and former prominent faculty members at each, have pushed the envelope of skull base endoscopy. We did not quantify self-citation in the present study, and so the sheer volume of publications from these institutions may have increased their number of top articles, due to subsequent publications citing earlier works from the same authors. Nevertheless, 17 other institutions produced at least one top-cited paper, demonstrating also the breadth of

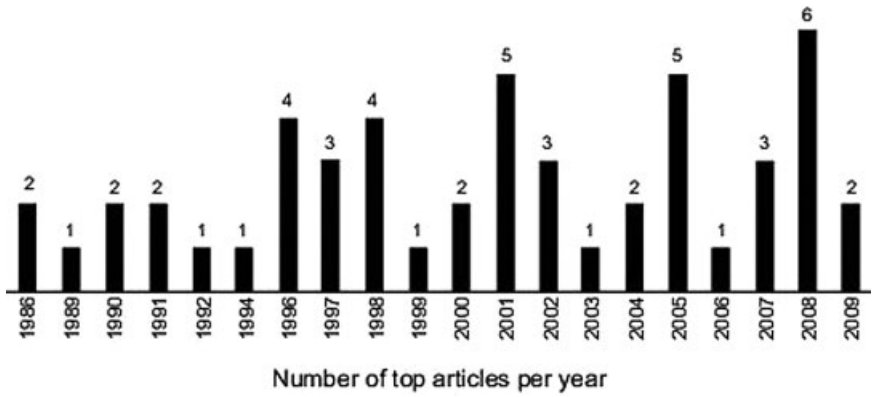

Fig. 2 Top 50 most-cited skull base endoscopy articles published per year; $n = 51$, due to articles with equal citation counts.

institutions publishing the most-cited articles. Most of the top articles originated from institutions within the United States and Canada (61%). We also identified a strong European influence on the top 50 publications; 35% of the top articles originated from institutions in Italy, Germany, Austria, and the Netherlands. This result is partially a by-product of our study design because we included only English-language articles. Therefore, potentially high-impact articles published in Chinese- or Japanese-language neurosurgical journals were not captured.

The top publications varied in subject matter. As might be expected of a relatively young subspecialty, many highly cited articles were case series from individual institutions demonstrating the clinical possibilities of endoscopic skull base surgery. The largest of these series were from the otolaryngology literature detailing sinonasal anatomy and approaches, whereas the purely endoscopic endonasal publications tended to include smaller numbers of patients. Similarly, we found numerous articles (including the most-cited publication) focused on innovative operative techniques, such as the vascularized nasal mucosal flap.[13] However, at present, no top-50 publication focuses on patient quality-of-life outcomes. Now that endoscopy has advanced into the mainstream of neurosurgery, these studies, along with cost-effectiveness analyses, will likely emerge. Randomized controlled trials are lacking in the field of neurosurgery as a whole, and skull base endoscopy is no different. It remains to be seen if in the coming decades randomized trials within skull base endoscopy will join the most-cited publications.

Lastly, we noted that the overwhelming majority (96%) of top-50 articles were published in journals specific to neurosurgery and otolaryngology. No top article was published in a flagship general medical journal such as the *New England Journal of Medicine*. This perhaps reflects the lack of large randomized clinical trials, but it also speaks to the relatively narrow audience of endoscopic skull base surgery as a subspecialty.

Table 3 Institutional contributions to top articles[a]

Institution	No. of publications
University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, United States	18
University of Naples Federico II, Naples, Italy	8
Weill Medical College, Cornell University, Ithaca, New York, United States	4
Johannes Gutenberg University of Mainz, Mainz, Germany	3
Medical University of Graz, Graz, Austria	3
Loyola University, Chicago, Illinois, United States	2
Other (1 top publication)	13

[a]Determined by affiliation of lead author at time of article publication as reported by journal.

Table 4 Types of articles comprising the most-cited skull base endoscopy publications

Study type	No. of publications
Clinical case series	19
Endoscopic technique	12
Anatomy	6
Complications	5
Overview/Review	5
Technology	2
Meta-analysis	2
Economic studies	0
Quality-of-life studies	0
Randomized clinical trial	0

Table 5 Journals in which the top skull base endoscopy articles were published

Journal name	No. of publications
Neurosurgery	13
Laryngoscope	12
Journal of Neurosurgery	5
Neurosurgical Focus	5
Minimally Invasive Neurosurgery	4
Otolaryngology - Head and Neck Surgery	3
Other (fewer than three top-50 publications)[a]	9

[a]Includes only 2 journals for specialties other than neurosurgery or otolaryngology.

Almost all articles identified in the top 50 focused on endonasal endoscopy. Very few articles included endoscopic-assisted craniotomy approaches to the posterior aspect of the skull base such as retrosigmoid approaches. The endonasal approach to the anterior skull base is the centerpiece of neurosurgical skull base endoscopy, reflected in the literature trends identified. We did not include intraventricular or intraparenchymal endoscopy articles within the present study because our focus was on endoscopic approaches to the skull base. The pathology treated, operative technique, and overall application of intraventricular endoscopy is quite different than those of the skull base endoscopy approach; thus we did not feel including such articles was appropriate.

Neurosurgery and otolaryngology share common expertise in the endonasal approach to the skull base. This is reflected in the top 50 articles identified, in which prominent surgeons from both specialties are represented among the contributing authors. Several top articles such as the early works by Stammberger and colleagues (articles ranked 2, 4, and 5) focus entirely on otolaryngology approaches to sinonasal pathology.[14–16] These articles are a foundation on which neurosurgeons and otolaryngologists alike have built more complex approaches to intracranial pathology.

All medical bibliographic analyses have inherent limitations, and our study is no different. Our data analysis relies entirely on the successful identification and capture of publications using a web-based library search, Web of Science. Other authors have successfully used modifications of Google Scholar as well as other databases; each method has benefits and limitations. To avoid missing top articles, we searched using more generic phrases and then manually culled irrelevant publications rather than attempting highly specific searches. Furthermore, we manually searched all journals in which a top-50 article was published for highly generic phrases ("endoscop*," where "*" is a wildcard character that would capture such phrases as "endoscopy" and "endoscopic") and found no additional relevant top articles, suggesting our search was adequately broad. Article citations are constantly in flux, and so our work must be considered a snapshot in time rather than a definitive ranking. We anticipate that, with the ever-increasing number of related articles being published, article citation rankings will change, and repeating our search with the same criteria in the future may yield different results.

Our ranking of the top 50 most-cited articles is predicated on the idea that more impactful and important publications receive more citations. This is an imperfect assumption but has been largely accepted by bibliographic studies as an inherent limitation of the research methodology. There are undoubtedly highly educational papers or articles of important historical note that are not adequately valued by their citation counts alone. Nevertheless, citation by peer researchers remains an internationally recognized metric by which publication impact can be assessed.

Few standardized curricula exist for trainees within endoscopic skull base surgery. These top publications constitute an skull base endoscopy syllabus, and they can be incorporated into resident and fellow education as the first canon of a relatively young field. Over the coming decades, new skull base endoscopy techniques may give rise to a second generation of top-50 publications.

Conclusions

We have identified the most-cited peer-reviewed research papers within the relatively small and young field of skull base endoscopy that may be considered significant classic works. Many of these publications come from only a handful of institutions that have driven the field forward in the last 2 decades. Randomized clinical trials, as well as patient quality-of-life and economic impact studies, are still absent from these most-cited publications, and it remains to be seen when such publications will enter the mainstream of skull base endoscopy. We have also established median baselines for total citations and citations per year for individual publications. These statistics will allow researchers to compare their relative impact with that of their peers within the subspecialty of skull base endoscopy. Lastly, these top articles may be useful to surgical trainees as a syllabus for skull base neurosurgery.

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