Bibliometric analysis of the top 100 most cited articles on the basilar artery

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INTRODUCTION

The basilar artery (BA) is formed by the joining of two vertebral arteries at the pontomedullary junction. It courses close to the brainstem and terminates at the pontomesencephalic sulcus (in almost 80% people). It divides into an inferior branch (superior cerebellar artery) and a superior branch (posterior cerebral artery). In addition to small perforating arteries, multiple vessels connecting to the brainstem originate from the BA trunk. The BA can be affected by various disease processes, such as BA occlusion (1% of ischemic stroke) due to thrombus formation from atheromas (26–36%) or thrombus embolism (30–35%). Further, BA aneurysm is another disease process, and the BA tip aneurysm variant...
is the most common posterior circulation aneurysm (15% of all intracranial aneurysms).\cite{9,17} BA vasospasm occurs after aneurysmal subarachnoid hemorrhage of the posterior circulation. In contrast to anterior circulation vasospasm, the BA vasospasm usually spares the brainstem from any infarction due to the abundant blood supply.\cite{7}

Bibliometric analysis is a citation-based assessment of the significance and impact of individual articles in their respective fields. It is considered a new research method and was officially defined and introduced in 1969.\cite{19} Bibliometric analysis has gradually gained the approval of the scientific community as it introduces interested clinicians of different specialties to the subject analyzed in the article.\cite{8,16} It also explores the chronological trend of publication evolution, especially in relation to topics with large amounts of data in the literature. The utility of citation analysis is to conglomerate evidence-based studies and approaches to diseases while studying the changes in medical practice trends. Therefore, it holds paramount importance for young clinicians and scientists. Multiple citation analyses in neurosurgery have previously been published.\cite{1,2,4} In the current paper, we present a bibliometric analysis of the top 100 articles on BA.

**MATERIALS AND METHODS**

The Scopus database was used to perform a title-specific search with no time restriction in June 2020, aiming to identify the most impactful articles published on BA "Basilar artery" was used as the keyword for the search to define the most-cited works on the same. The top 100 most-cited articles were selected for further analysis. Pertinent bibliometric parameters were obtained for analysis. The factors included the following: article-based parameters (Title, CC, C.Y., year of publication, and country of publication); journal-based parameters (publishing journal, SNIP, SJR, IF); and an author-based parameter (H-index, the specialty of the 1st author).

A comprehensive review of the most-cited articles was performed to classify them. The top 100 articles yielded were classified into the following eight categories: (1) clinical, (2) clinicopathological, (3) clinicoradiological, (4) endovascular management, (5) surgical management, (6) medical management, (7) neuroanatomical, and (8) experimental.

**RESULTS**

The data search included 3354 articles published between 1833 and 2020. The top 100 highly cited articles were published between 1946 and 2015, with a total of 13,595 citations and an average of 135.95 citations per article, in which the rate of self-citation for all authors accounted for 7.84% in the list [Table 1]. The most productive era of research on the BA was in the 1990s [Figure 1]. Over the 70 years, the top three most studied entities relevant to the BA were, in descending order, as follows: experimental, endovascular management, and clinical studies [Figure 2]. The United States of America was the country that contributed the most to the cited articles [Figure 3]. An analysis of the institutes that contributed three articles or more showed that the University of Bern has the highest number of articles in the list, accounting for ten articles [Figure 4]. Over the years of publication, the *Journal of Neurosurgery* contributed the most to the literature, accounting for 25 articles [Figure 5]. An in-depth assessment of the highest contributing authors by specialty showed that neuroradiologists’ contributions were the most substantial at a total of 20 published articles. The most prolific author was Vanhoutte, a biologist who contributed to six articles on the list [Figure 6].

In *Stroke*, Brandt *et al.* (1996) published the most-cited article on the BA, titled “Thrombolytic therapy of acute BA occlusion: variables affecting recanalization and outcome.” It received a total of 435 citations at 18.12 citations/year.

**DISCUSSION**

Initial studies of the top 100 cited articles on BA were diverse and mostly in the clinical category, with a significant focus on defining different disease patterns. BA thrombosis...
### Table 1: The top 100 most-cited articles on the basilar artery.

| Rank | Authors                  | Title                                                                 | Journal                          | CC  | CY  |
|------|--------------------------|----------------------------------------------------------------------|----------------------------------|-----|-----|
| 1st  | Brandt *et al.*, 1996    | Thrombolytic therapy of acute basilar artery occlusion: variables affecting recanalization and outcome | *Stroke*                         | 435 | 18.12 |
| 2nd  | Higashida *et al.*, 1997 | Intravascular stent and endovascular coil placement for a ruptured fusiform aneurysm of the basilar artery. Case report and review of the literature | *Journal of Neurosurgery*         | 355 | 15.43 |
| 3rd  | Schonewille *et al.*, 2009 | Treatment and outcomes of acute basilar artery occlusion in the Basilar Artery International Cooperation Study (BASICS): a prospective registry study | *The Lancet Neurology*            | 345 | 31.36 |
| 4th  | Lindsberg and Mattle, 2006 | Therapy of basilar artery occlusion: a systematic analysis comparing intra-arterial and intravenous thrombolysis | *Stroke*                         | 330 | 23.57 |
| 5th  | Kawase *et al.*, 1985    | Transpetrosal approach for aneurysms of the lower basilar artery     | *Journal of Neurosurgery*         | 290 | 8.28 |
| 6th  | Kubik and Adams, 1946    | Occlusion of the basilar artery – a clinical and pathological study   | *Brain*                          | 269 | 3.53 |
| 7th  | Steinberg, 1993          | Deliberate basilar or vertebral artery occlusion in the treatment of intracranial aneurysms. Immediate results and long-term outcome in 201 patients | *Journal of Neurosurgery*         | 268 | 9.92 |
| 8th  | Lanzino *et al.*, 1999   | Efficacy and current limitations of intravascular stents for intracranial internal carotid, vertebral, and basilar artery aneurysms | *Journal of Neurosurgery*         | 264 | 12.57 |
| 9th  | Saeki and Rhoton, 1977   | Microsurgical anatomy of the upper basilar artery and the posterior circle of Willis | *Journal of Neurosurgery*         | 245 | 5.9  |
| 10th | Chimowitz, 1998          | Prognosis of patients with symptomatic vertebral or basilar artery stenosis | *Stroke*                         | 234 | 10.63 |
| 11th | Higashida *et al.*, 1993 | Transluminal angioplasty for atherosclerotic disease of the vertebral and basilar arteries | *Journal of Neurosurgery*         | 232 | 8.59 |
| 12th | Archer and Horenstein, 1977 | Basilar artery occlusion: clinical and radiological correlation | *Stroke*                         | 228 | 5.3  |
| 13th | Bickerstaff, 1961        | BASILAR ARTERY MIGRAINE                                              | *The Lancet*                     | 224 | 3.79 |
| 14th | Katusic *et al.*, 1984   | Vasopressin causes endothelium-dependent relaxations of the canine basilar artery | *Circulation Research*            | 204 | 5.66 |
| 15th | Mattle *et al.*, 2011    | Basilar artery occlusion                                             | *The Lancet Neurology*           | 190 | 21.11 |
| 16th | Sundt *et al.*, 1980     | Transluminal angioplasty for basilar artery stenosis                 | *Mayo Clinic Proceedings*         | 188 | 4.7  |
| 17th | Segarra, 1970            | Cerebral Vascular Disease and Behavior: I. The Syndrome of the Mesencephalic Artery (Basilar Artery Bifurcation) | *Archives of Neurology*           | 182 | 3.64 |
| 18th | Fisher and Caplan, 1971  | Basilar artery branch occlusion: a cause of pontine infarction       | *Neurology*                      | 182 | 3.71 |
| 19th | Smoker *et al.*, 1986    | High-resolution computed tomography of the basilar artery. II. Vertebrobasilar dolichoectasia: clinical-pathologic correlation and review | *American Journal of Neuroradiology* | 179 | 5.26 |
| 20th | Arnold *et al.*, 2004    | Clinical and radiological predictors of recanalization and outcome of 40 patients with acute basilar artery occlusion treated with intra-arterial thrombolysis | *Journal of Neurology, Neurosurgery and Psychiatry* | 179 | 11.18 |
| 21st | Percheron, 1976          | Arteries of the human thalamus: II. Paramedian thalamic arteries and territories from the basilar communicating artery [LES ARTERES DU THALAMUS HUMAIN. II. ARTERES ET TERRITOIRES THALAMIQUES PARAMEDIANS DE L’ARTERE BASILAIRE COMMUNICANTE] | *Revue Neurologique*              | 178 | 4.04 |
| 22nd | Gomez *et al.*, 2000     | Elective stenting of symptomatic basilar artery stenosis             | *Stroke*                         | 177 | 8.85 |
| 23rd | Spetzler *et al.*, 1988  | Aneurysms of the basilar artery treated with circulatory arrest, hypothermia, and barbiturate cerebral protection | *Journal of Neurosurgery*         | 177 | 5.53 |
| 24th | Faraci, 1990             | Role of nitric oxide in regulation of basilar artery tone *in vivo*  | *American Journal of Physiology - Heart and Circulatory Physiology* | 173 | 5.76 |

(Contd..)
| Rank | Authors                  | Title                                                                 | Journal                                      | CC  | CY  |
|------|--------------------------|----------------------------------------------------------------------|----------------------------------------------|-----|-----|
| 25th | Ferbert et al., 1990     | Clinical features of proven basilar artery occlusion                 | Stroke                                       | 171 | 5.7 |
| 26th | Kulcsár et al., 2010     | High-profile flow diverter (Silk) implantation in the basilar artery: efficacy in the treatment of aneurysms and the role of the perforators | Stroke                                       | 155 | 15.5|
| 27th | Lindsberg et al., 2004   | Long-term outcome after intravenous thrombolysis of basilar artery occlusion | Journal of the American Medical Association  | 152 | 9.5 |
| 28th | Voetsch et al., 2004     | Basilar artery occlusive disease in the New England Medical Center Posterior Circulation Registry | Archives of Neurology                        | 150 | 9.375|
| 29th | Day et al., 1994         | Extradural temporopolar approach to lesions of the upper basilar artery and infrachiasmatic region | Journal of Neurology                         | 148 | 5.69|
| 30th | Katusic et al., 1987     | Endothelium-dependent contraction to stretch in canine basilar arteries | American Journal of Physiology - Heart and Circulatory Physiology | 147 | 4.45|
| 31st | Parsons et al., 1989     | 5-HT1-like receptors mediate 5-hydroxytryptamine-induced contraction of human isolated basilar artery | British Journal of Pharmacology Stroke      | 146 | 4.7 |
| 32nd | Caplan, 1979             | Occlusion of the vertebral or basilar artery: follow-up analysis of some patients with benign outcome | American Journal of Neuroradiology Brain    | 132 | 5.73|
| 33rd | Cross et al., 1997       | Relationship between clot location and outcome after basilar artery thrombolysis | Stroke                                       | 128 | 11.63|
| 34th | Marquardt et al., 2009   | Incidence and prognosis of <50 symptomatic vertebral or basilar artery stenosis: prospective population-based study | Stroke                                       | 128 | 10.66|
| 35th | Puetz et al., 2008       | Extent of hypoattenuation on CT angiography source images predicts functional outcome in patients with basilar artery occlusion | Stroke                                       | 127 | 2.15|
| 36th | Drake, 1961              | Bleeding aneurysms of the basilar artery. Direct surgical management in four cases | Journal of Neurosurgery                      | 125 | 3.2 |
| 37th | Sasaki et al., 1981      | The effect of a lipid hydroperoxide of arachidonic acid on the canine basilar artery. An experimental study on cerebral vasospasm | Neurosurgery                                  | 122 | 5.08|
| 38th | Pierot et al., 1996      | Selective occlusion of basilar artery aneurysms using controlled detachable coils: report of 35 cases | American Journal of Physiology - Heart and Circulatory Physiology Neurosurgery and Psychiatry | 120 | 4.44|
| 39th | Kitazono et al., 1993    | Role of ATP-sensitive K+ channels in CGRP-induced dilatation of basilar artery in vivo | Journal of Neurology                         | 120 | 8   |
| 40th | Schonewille et al., 2005 | Outcome in patients with basilar artery occlusion treated conventionally | Journal of Neurosurgery                      | 118 | 5.61|
| 41st | Bavinzski et al., 1999   | Treatment of basilar artery bifurcation aneurysms using Guglielmi detachable coils: a 6-year experience | Journal of Neurosurgery                      | 117 | 4.33|
| 42nd | Langton, 1993            | Calcium channel currents recorded from isolated myocytes of rat basilar artery are stretch sensitive | The Journal of Physiology                    | 117 | 3.44|
| 43rd | Smoker et al., 1986      | High-resolution computed tomography of the basilar artery: I. Normal size and position | Stroke                                       | 115 | 3.38|
| 44th | Mouflarri et al., 1986   | Basilar and distal vertebral artery stenosis: long-term follow-up | Annals of Neurology                          | 114 | 23.4|
| 45th | Singer et al., 2015      | Mechanical recanalization in basilar artery occlusion: the ENDOSTROKE study | (Contd...)                                   | 8   | 23.4|

Table 1: (Continued).
| Rank | Authors                     | Title                                                                 | Journal                                      | CC | CY |
|------|-----------------------------|----------------------------------------------------------------------|----------------------------------------------|----|----|
| 46th | Allen *et al.*, 1974        | Cerebral arterial spasm. 1. In vitro contractile activity of vasoactive agents on canine basilar and middle cerebral arteries. | *Journal of Neurosurgery*                    | 114 | 2.47 |
| 47th | Klein *et al.*, 2010        | Basilar artery atherosclerotic plaques in paramedian and lacunar pontine infarctions: a high-resolution MRI study                         | *Stroke*                                     | 112 | 11.2 |
| 48th | Kim *et al.*, 1992          | Reduced production of cGMP underlies the loss of endothelium-dependent relaxations in the canine basilar artery after subarachnoid hemorrhage | *Circulation Research*                       | 112 | 4   |
| 49th | Connor *et al.*, 1989       | Characterization of 5-HT receptors mediating contraction of canine and primate basilar artery by use of GR43175, a selective 5-HT1-like receptor agonist | *British Journal of Pharmacology, Neurosurgery and Psychiatry* | 112 | 3.61 |
| 50th | Fisher, 1977                | Bilateral occlusion of basilar artery branches                        |                                              | 109 | 2.53 |
| 51st | Katusic *et al.*, 1993      | Endothelium-dependent contractions to oxygen-derived free radicals in the canine basilar artery | *American Journal of Physiology - Heart and Circulatory Physiology* | 109 | 4.03 |
| 52nd | Fuji *et al.*, 1991         | Flow-mediated dilatation of the basilar artery *in vivo*              | *Circulation Research*                       | 109 | 3.75 |
| 53rd | Drake, 1975                 | Ligation of the vertebral (unilateral or bilateral) or basilar artery in the treatment of large intracranial aneurysms               | *Journal of Neurosurgery*                    | 109 | 2.42 |
| 54th | Katusic *et al.*, 1988      | Endothelium-dependent contractions to calcium ionophore a23187, arachidonic acid, and acetylcholine in canine basilar arteries        | *Stroke*                                     | 108 | 3.37 |
| 55th | Nishizaki *et al.*, 1986    | Dolichoectatic basilar artery: a review of 23 cases                   | *Stroke*                                     | 104 | 3.05 |
| 56th | Mayhan, 1990                | Impairment of endothelium-dependent dilatation of basilar artery during chronic hypertension                                  | *American Journal of Physiology - Heart and Circulatory Physiology* | 102 | 3.4   |
| 57th | Toda, 1974                  | The action of vasodilating drugs on isolated basilar, coronary, and mesenteric arteries of the dog.                              | *Journal of Neurosurgery*                    | 102 | 2.21 |
| 58th | Phatouros *et al.*, 1999    | Endovascular stenting of an acutely thrombosed basilar artery: technical case report and review of the literature                  | *Neurosurgery*                               | 99  | 4.71 |
| 59th | Kim *et al.*, 1992          | Alterations in endothelium-dependent responsiveness of the canine basilar artery after subarachnoid hemorrhage                     | *Journal of Neurosurgery*                    | 99  | 3.09 |
| 60th | Mayer *et al.*, 2002        | Treatment of basilar artery embolism with a mechanical extraction device: necessity of flow reversal                             | *Stroke*                                     | 97  | 5.39 |
| 61st | Allen and Banghart, 1979    | Cerebral arterial spasm: Part 9. *In vitro* effects of nifedipine on serotonin-, phenylephrine-, and potassium-induced contractions of canine basilar and femoral arteries | *Neurosurgery*                               | 97  | 2.36 |
| 62nd | Sturzenegger and Meienberg, 1985 | Basilar Artery Migraine: a Follow-up Study of 82 Cases                  | *Headache: The Journal of Head and Face Pain* | 95  | 2.71 |
| 63rd | Black and Ansbacher, 1984   | Saccular aneurysm associated with segmental duplication of the basilar artery. A morphological study                              | *Journal of Neurosurgery*                    | 94  | 2.61 |
| 64th | Wijdicks *et al.*, 1997     | Intra-arterial thrombolysis in acute basilar artery thromboembolism: the initial mayo clinic experience                          | *Mayo Clinic Proceedings*                    | 94  | 4.08 |
| 65th | Kwan *et al.*, 1991         | Enlargement of basilar artery aneurysms following balloon occlusion – 'water-hammer effect'. Report of two cases                | *Journal of Neurosurgery*                    | 93  | 3.44 |

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| Rank | Authors             | Title                                                                 | Journal                        | CC  | CY  |
|------|---------------------|-----------------------------------------------------------------------|--------------------------------|-----|-----|
| 66th | Chen et al., 1997   | Expression and function of recombinant endothelial nitric oxide synthase gene in canine basilar artery | Circulation Research           | 93  | 4.04|
| 67th | Golden and French, 1975 | Basilar artery migraine in young children                          | Pediatrics                     | 92  | 2.04|
| 68th | Cross et al., 1998 | Collateral circulation and outcome after basilar artery thrombolysis | American Journal of Neuroradiology | 92  | 4.18|
| 69th | Campos et al., 1987 | Saccular aneurysms in basilar artery fenestration                    | American Journal of Neuroradiology | 91  | 2.75|
| 70th | Gruber et al., 1999 | A comparison between endovascular and surgical management of basilar artery apex aneurysms | Journal of Neurosurgery         | 91  | 4.33|
| 71st | Zeumer et al., 1982 | Local fibrinolysis in basilar artery thrombosis                      | Deutsche Medizinische Wochenschrift | 91  | 2.39|
| 72nd | Terada et al., 1996 | Transluminal angioplasty for arteriosclerotic disease of the distal vertebral and basilar arteries | Journal of Neurology and Psychiatry | 91  | 3.79|
| 73rd | Abtin et al., 1998 | Basilar artery perforation as a complication of endoscopic third ventriculostomy | Pediatric Neurosurgery          | 90  | 4.09|
| 74th | Nijensohn et al., 1974 | Clinical significance of basilar artery aneurysms                 | Neurology                       | 89  | 1.93|
| 75th | Sugita et al., 1979 | Microneurosurgery for aneurysms of the basilar artery               | Journal of Neurosurgery         | 89  | 2.17|
| 76th | Tosaka et al., 2001 | Sphingosine 1-phosphate contracts canine basilar arteries in vitro and in vivo: possible role in pathogenesis of cerebral vasospasm | Stroke                          | 88  | 4.63|
| 77th | Lee et al., 1976    | Neurogenic sympathetic vasoconstriction of the rabbit basilar artery | Circulation Research            | 88  | 2   |
| 78th | Devuyt et al., 2002 | Stroke or transient ischemic attacks with basilar artery stenosis or occlusion: clinical patterns and outcome | Archives of Neurology           | 87  | 4.83|
| 79th | Echlin, 1965        | Spasm of basilar and vertebral arteries caused by experimental subarachnoid hemorrhage. | Journal of Neurosurgery         | 87  | 1.58|
| 80th | von et al., 1990    | Evidence for two separate vasoconstriction-mediated nucleotide receptors, both distinct from the P2X-receptor, in rabbit basilar artery; a receptor for pyrimidine nucleotides and a receptor for purine nucleotides | Naunyn-Schmiedeberg's Archives of Pharmacology | 87  | 2.9 |
| 81st | Sano, 1980          | Temporopolar approach to aneurysms of the basilar artery at and around the distal bifurcation; technical note | Neurological Research           | 87  | 2.25|
| 82nd | Valencia et al., 2006 | Blood flow dynamics in saccular aneurysm models of the basilar artery | Journal of Biomechanical Engineering | 86  | 6.14|
| 83rd | Zubkov et al., 2000 | Mechanism of endothelin-1-induced contraction in rabbit basilar artery | Stroke                          | 86  | 4.3 |
| 84th | Drake, 1965         | Surgical treatment of ruptured aneurysms of the basilar artery. Experience with 14 cases. | Journal of Neurosurgery         | 86  | 1.56|
| 85th | McDowell et al., 1961 | The natural history of internal carotid and vertebral-basilar artery occlusion | Neurology                       | 85  | 1.44|
| 86th | Hong et al., 1998   | Vertebral artery dominance contributes to basilar artery curvature and peri-vertebrobasilar junctional infarcts | Journal of Neurology, Neurosurgery and Psychiatry | 85  | 7.27|
| 87th | Fujiwara et al., 1986 | Selective hemoglobin inhibition of endothelium-dependent vasodilation of rabbit basilar artery | Journal of Neurosurgery         | 85  | 2.5 |
| 88th | Tanishima, 1980     | Cerebral vasospasm: contractile activity of hemoglobin in isolated canine basilar arteries | Journal of Neurosurgery         | 85  | 2.125|
| 89th | Fisher, 1970        | Occlusion of the Vertebral Arteries: causing Transient Basilar Symptoms | Archives of Neurology           | 84  | 1.68|
| 90th | Wallace et al., 1997 | Basilar artery rethrombosis: successful treatment with platelet glycoprotein IIb/IIIa receptor inhibitor | American Journal of Neuroradiology | 84  | 3.65|

(Contd...)
Table 1: (Continued).

| Rank | Authors                  | Title                                                                 | Journal                       | CC  | CY  |
|------|--------------------------|----------------------------------------------------------------------|-------------------------------|-----|-----|
| 91st | Kasuya et al., 1995      | Nitric oxide synthase and guanylate cyclase levels in canine basilar artery after subarachnoid hemorrhage | Journal of Neurosurgery       | 83  | 3.32|
| 92nd | Lee and Sarwinski, 1991  | Nitric oxidergic neurogenic vasodilation in the porcine basilar artery | Journal of Vascular Research  | 83  | 2.86|
| 93rd | Mayhan, 1992             | Impairment of endothelium-dependent dilatation of the basilar artery during diabetes mellitus | Brain Research               | 82  | 2.92|
| 94th | Uda et al., 2001         | Endovascular treatment of basilar artery trunk aneurysms with Guglielmi detachable coils: clinical experience with 41 aneurysms in 39 patients | Journal of Neurosurgery       | 81  | 4.26|
| 95th | Batjer and Samson, 1989  | Causes of morbidity and mortality from surgery of aneurysms of the distal basilar artery | Neurosurgery                  | 80  | 2.58|
| 96th | Nagel et al., 2009       | Therapy of acute basilar artery occlusion: intra-arterial thrombolysis alone versus bridging therapy | Stroke                        | 80  | 7.27|
| 97th | Drake, 1968              | The surgical treatment of aneurysms of the basilar artery            | Journal of Neurosurgery       | 80  | 1.53|
| 98th | Tanaka et al., 2006      | Relationship between variations in the circle of Willis and flow rates in internal carotid and basilar arteries determined by means of magnetic resonance imaging with semiautomated lumen segmentation: reference data from 125 healthy volunteers | American Journal of Neuroradiology | 79  | 5.64|
| 99th | Klein et al., 2005       | High-resolution MRI identifies basilar artery plaques in paramedian pontine infarct | Neurology                     | 78  | 5.2 |
| 100th| Quiñones-Hinojosa et al., 2004 | Transcranial Motor Evoked Potentials during Basilar Artery Aneurysm Surgery: technique Application for 30 Consecutive Patients | Neurosurgery                  | 78  | 4.87|

and migraine were popular in the 1900s–1960s. In the 1960s–1970s, authors were interested in studying the detailed surgical anatomy of the cerebral circulation, including BA. The utilization of computed tomography (CT) to study the anatomy of BA and its different pathologies was also popular. More publications using endovascular techniques were witnessed in the 1990s. Clinicians tried different endovascular modalities in managing BA aneurysms and occlusion for their utility in managing BA aneurysms and occlusion. Animal experiments on the molecular pathways of vasospasm continued with advancements in laboratory techniques. Studies comparing the efficacy and outcome of microsurgical and endovascular modalities in managing BA aneurysms and thrombosis were also popular. Besides endovascular techniques, experimental studies on cerebral vasospasm in animals were popular in the 1970s. The utilization of computed tomography (CT) to study the anatomy of BA and its different pathologies was also popular. The natural history of BA aneurysm was dimal and with no active intervention. An aneurysm was dormant until the 1960s, when it was often removed.
been on the endovascular management of BA aneurysms and thrombosis, and the pattern is rapidly evolving with newer techniques and devices.

The article with the highest number of citations overall (in both the medical and endovascular categories), that is, 435 CC and 18.12 CY, is “Thrombolytic therapy of acute BA occlusion: variables affecting recanalization and outcome” by Brandt et al. (1996) in Stroke. The study concluded that multiple important factors dictate the outcome of BA occlusion by a thrombus embolism or an atheroma. Patients who received intra-arterial or venous thrombolysis had a mortality rate of 46%, while the nontrombolytic group had a 92% mortality.
rate \((P < 0.0004)\). In addition, variables that affect mortality are the location of occlusion \((P < 0.0011)\), patient’s age \((P < 0.0008)\), and collateral circulation status \((P < 0.04)\).[6]

The second highest cited article (second in the endovascular category), with 355 CC and 15.43 CY, is “Intravascular stent and endovascular coil placement for a ruptured fusiform aneurysm of the BA. Case report and review of the literature” by Higashida et al. (1997) in the Journal of Neurosurgery. The article was the first of its kind to describe the endovascular management of a ruptured BA fusiform aneurysm using stents and Guglielmi detachable coils.[10]

**Experimental category**

The experimental category (peak publications in 1990–1997) had the highest publication number of all the categories. Studies performed on animal subjects in the 1970s and 1980s tested the vasospastic activities of BA in induced subarachnoid hemorrhage or the administration of vasoactive materials, such as serotonin and phenylephrine. Over the next years, researchers studied the intracellular pathways of vasospasm using BA and other intracranial vessels. Further, authors tested the various factors that may play a role in vasospasm, such as lipid hydroperoxides. Some authors researched the blood flow turbulence in vessels with aneurysms. The highest-cited article in the category (ranked 14th overall), with 204 CC and 5.66 CY, is “Vasopressin causes endothelium-dependent relaxations of the canine basilar artery” by Katusic et al. (1984) in Circulation Research. The experiments showed that endothelium mediates vascular relaxation induced by vasopressin; the absence of endothelium negates the vascular dilation activity of vasopressin.[11]

**Endovascular category**

The endovascular management category (peak publications in 1993–1999) contains one of the highest cited articles due to the revolutionary changes it brought with different, minimally invasive management of vascular pathologies. Initial papers help shed light on the possibility of managing BA occlusion with intra-arterial or venous thrombolysis. Simultaneously, other studies have demonstrated the efficacy of mechanical thrombectomy. Multiple articles published in the 1990s show the utility of stenting in BA stenosis. In addition, aneurysm research was possible due to evolutions...
in the different endovascular devices used for management, such as stent-assisted coiling. Afterward, flow diverters were introduced as a new modality to manage aneurysms. Some papers have compared the outcome of endovascular and surgical management of BA aneurysms.

The third highest cited article in the endovascular category (ranked 4th overall), with 330 CC and 23.57 CY, is “Therapy of BA occlusion: a systematic analysis comparing intra-arterial and intravenous thrombolysis” by Lindsberg and Mattle (2006) in Stroke. The authors found no difference between the outcomes of intravenous and intra-arterial thrombolysis; however, recanalization rates were higher in intra-arterial than in intravenous thrombolysis ($P < 0.05$).[14]

Clinical category

The clinical category (peak publications in 2002–2015) was mainly focused on the study of BA occlusion and stenosis from the 1960s to the 2010s. Most authors examined the natural history, outcome, and clinical presentation of BA occlusion and BA migraine. Different treatment modalities and their complications were described for BA occlusion over the following years.

The highest cited article in the clinical category (ranking 3rd overall), with 345 CC and the highest overall in terms of CY (31.36), is “Treatment and outcomes of acute BA occlusion in the BA International Cooperation Study (BASICS): a prospective registry study” by Schonewille et al. (2009) in The Lancet Neurology. This study divides patients who have BA occlusion into three groups: antithrombotic treatment group, intravenous or intra-arterial thrombolysis group, or intra-arterial therapy (mechanical thrombectomy). In patients with mild-to-moderate clinical presentation, there was no difference in the outcomes of the three groups; patients with severe presentations were found to have an unfavorable prognosis in the antithrombotic treatment group as compared to intravenous/arterial thrombolysis or intra-arterial therapy. However, there was no difference between intravenous/arterial thrombolysis and intra-arterial therapy in the severe presentation group.[21]

Clinicopathologic category

The clinicopathologic category (peak publications in 1984–1987) focused on defining the clinical presentation and pathophysiology of BA occlusion, aneurysm, and dolichoectasia. The highest cited article in the category (ranked 6th overall), with 269 CC and 3.53 CY, is “Oclusion of the basilar artery – a clinical and pathological study” by Kubik and Adams (1946) in Brain. The authors examined 18 autopsies for BA occlusion and studied the mechanism of occlusion through thrombus embolism or atheroma-induced thrombosis, considering the symptomatology of this disease.[13]
The surgical management category had a bimodal peak publication in 1961–1968 and 1980–1988. In the 1960s, the technical notes of successful BA aneurysms clippings were surging, followed by alternative surgical approaches to aneurysms along the entire length of the BA. In the 1980s, some authors published papers on the utility of hypothermia, circulatory arrest, and barbiturate coma in surgically managing complex BA aneurysms. The highest cited article in the category (ranked 5th overall), with 290 CC and 8.28 CY, is “Transpetrosal approach for aneurysms of the lower basilar artery” by Kawase et al. (1985) in the Journal of Neurosurgery. The authors demonstrated that the extradural subtemporal approach and drilling of the anterior pyramidal bone yield a large operative corridor for proximal BA aneurysms, sparing the temporal lobe and cranial nerves and avoiding brainstem retraction injury.[12]

The neuroanatomy category publications peaked in 1976–1977. Initially, the authors studied the surgical anatomy of the posterior circulation, including the different variations of the BA's orientation, route, and branches. Further, the BA average caliber and variations were studied in addition to the essential perforators to the brainstem and thalamus. Later, articles were focused on the BA radio-anatomical correlation using CT scans and cadaveric specimens. The highest cited article in the category (ranked 9th overall), with 245 CC and 5.9 CY, is “Microsurgical anatomy of the upper basilar artery and the posterior circle of Willis” by Saeki and Rhoton Jr. (1977) in the Journal of Neurosurgery. The authors have described the detailed anatomy of the upper segment of the posterior circulation to the posterior cerebral arteries. The largest segment, branch, number of perforators in each segment, and incidence of different variations and hypoplastic vessels have been described.[20]

The clinicoradiological category (peak publications in 2005–2010) mainly consists of BA occlusion studies. Initial studies researched the radiological appearance of BA occlusion. In the 21st century, studies focused on high-resolution magnetic resonance imaging (MRI) to identify intra-luminal atheromas; concurrently, other studies used CT angiogram to predict functional outcome in patients with BA occlusion. The highest cited article in the category (ranked 12th overall), with 228 CC and 5.8 CY, is “Basilar artery occlusion: clinical and radiological correlation” by Archer and Horenstein (1977) in Stroke. The authors concluded that the extent of BA occlusion and low level of consciousness at presentation are poor prognostic factors.[13]

The medical management category (peak publications in 2004–2005) was focused on the use of antiplatelet or anticoagulation for the management of BA occlusion. Later, the authors compared observation-only management and the use of anti-platelets or anticoagulation for BA occlusion. The second highest cited article (ranked 27th overall), with 152 CC and 9.5 CY, is “Long-term outcome after intravenous thrombolysis of basilar artery occlusion” by Lindsberg et al. (2004) in The Journal of the American Medical Association. Patients who received intravenous thrombolysis were followed at 3 months and 1 year for functional outcome and survival. At 3 months, the recanalization rate was 52%, and mortality was 40%; 24% were functionally independent, while 16% had a severe functional disability. At 1 year, 30% reached functional independence, and 46% died.[19]

Since the emergence of bibliometric reviews, many inherent limitations have been identified. The citation accumulation over time was found to be biased toward old articles, but the consideration of citations per year minimizes this predilection. The usage of citation count as a representative of the article's influence is not optimal for the following reasons: the number of citations does not reflect the value of the articles in a particular field, wherein peer-reviewed articles must be used with bibliometrics to complement the representation of field changing or impactful articles.[3]

Database-specific limitations in the Scopus search engine limit the full citation coverage dates in 1970–2020, and the citation count for articles published before this period may be underrepresented. Examination of the authors' self-citations as an inherent limitation of bibliometrics demonstrated a negligible effect in our study, at a rate of 7.4% for the total number of citations. Last, a publication in a highly impactful journal, based on their scientometric parameters, does not guarantee that all the publications in this journal are highly impactful in the studied field.[9]

The top-cited BA publications initially revolved around studying the natural history and management of BA occlusion, followed by the surgical anatomy of posterior circulation vessels. Subsequent articles focused on the surgical management of aneurysms and endovascular treatment of aneurysms as well as BA occlusion. Bibliometric analyses constitute a contemporary method of reviewing, analyzing, and summarizing highly cited articles. Most notably, top articles are cited for their impact in their respective fields and their evidence-based approach. We reviewed and analyzed the top 100 studies in BA to provide

CONCLUSION

The top-cited BA publications initially revolved around studying the natural history and management of BA occlusion, followed by the surgical anatomy of posterior circulation vessels. Subsequent articles focused on the surgical management of aneurysms and endovascular treatment of aneurysms as well as BA occlusion. Bibliometric analyses constitute a contemporary method of reviewing, analyzing, and summarizing highly cited articles. Most notably, top articles are cited for their impact in their respective fields and their evidence-based approach. We reviewed and analyzed the top 100 studies in BA to provide
an introductory article on BA multi-disciplinary publications for junior clinicians within related medical specialties. In addition, the publication trend may pave the way for novel research ideas in the future.

**Declaration of patient consent**

Patient’s consent not required as patients identity is not disclosed or compromised.

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**Conflicts of interest**

There are no conflicts of interest.

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