

The 100 most influential papers about cataract surgery: a bibliometric analysis

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Abstract

• **AIM:** To identify the 100 most cited papers in cataract surgery, we performed a comprehensive bibliometric analysis basing on the literature search on the Thomson Reuters Web of Knowledge.

• **METHODS:** The number of citations, including the total citations, latest 5y citations and average citation number per year (ACY), authorship, year of publication, major topics, journal of publication, country and institution of origin of each paper were recorded and then analyzed. Pearson's correlation analysis was conducted to evaluate the correlation between the published year and the number of citations. The correlation between journal's impact factor (IF) and number of citations was assessed as well.

• **RESULTS:** The most cited paper was the classic paper done by the European Society of Cataract & Refractive Surgeons (ESCRS) group. This paper focused on the topic of endophthalmitis. Not only the most cited papers originated from the USA, but also some American institutions like Johns Hopkins University, Harvard Medical School, etc. had the most citations. Pearson's correlation analysis indicated that the latest 5y citations and ACY were significantly related with the published year (5y citations: $r=0.615$, $P<0.001$; ACY: $r=0.657$, $P<0.001$), whereas no association between the total number of citations and published year was found ($r=0.045$). Moreover, the IFs of journals were found to have no significant effect on the number of total citations.

• **CONCLUSION:** To our knowledge, this is the first study on the most influential papers in cataract surgery after

a comprehensive research of relevant literatures. The present work may provide us concise information concerning the development history of cataract surgery over the past 66y.

• **KEYWORDS:** cataract surgery; citations; bibliometric analysis

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INTRODUCTION

Cataract, characterized with the opacity on the crystalline lens, can markedly restrict the routine activities of patients, such as reading, writing, walking and eventually reduce the quality of life^[1-3]. Cataract is the main cause of avoidable blindness^[4-6]. Despite some recent advances in the field of cataract potential drug treatments, surgery is still acknowledged to be the most effective treatment option^[7-10]. The cataract surgery has a long history and has advanced very quickly in the past decades^[11-13]. Generally, there are several basic surgical types, including phacoemulsification (Phaco), extracapsular cataract extraction (ECCE), manual small-incision cataract surgery (MSICS), and in particular, Phaco is the most commonly-used type now^[14-16].

The advances of cataract surgery are attributed to many excellent scientists and surgeons^[17]. Thanks to their contributions, modern cataract surgery can be performed in a standardized way in both developed and developing countries, curing millions of suffering patients^[18-20]. To our knowledge, this is the first study to quantify and analyze the most-cited papers about cataract surgery.

It is not easy to perfectly quantify the importance of a scientific paper to ophthalmologists, so we take "citation" as a surrogate for the influence of a paper. A citation is one paper's reference to another work, and thus acknowledges the contribution from this work. The citations would affect a journal's impact factor (IF), which is determined by dividing the "number of citations in this year" by the "number of articles published in that journal in the preceding two years". Thus, citation analysis can be used to determine the relative importance of a medical journal by means of the impact factor^[21-22]. To our knowledge, we are the first to present the most influential papers in the field of cataract surgery. Our aim is to do a bibliometric analysis on

Table 1 The 100 most-cited papers

Rank	First author	Citations	Rank	First author	Citations	Rank	First author	Citations
1	ESCRS	281	35	D. M. Meisler	126	69	S. Z. Li	97
2	M. Taban	256	36	K. Hayashi	125	70	B. C. K. Patel	97
3	T. A. Ciulla	242	37	C. S. Foster	124	71	B. A. Cooper	96
4	S. R. Irvine	241	38	R. V. Keech	123	72	N. J. C. Bauer	96
5	E. J. Hollick	229	39	P. G. Montan	122	73	D. J. Apple	95
6	P. Desai	224	40	D. R. Sherwood	122	74	H. K. Soong	95
7	E. P. Steinberg	211	41	T. Ferrer-Blasco	119	75	D. M. Meisler	94
8	O. D. Schein	209	42	C. Owsley	119	76	P. K. Nirmalan	94
9	G. R. J. Melles	186	43	S. E. Hankinson	117	77	P. S. Koch	93
10	Z. Nagy	186	44	T. Walkow	115	78	D. D. Koch	93
11	R. Beller	183	45	R. Klein	115	79	E. E. Birch	93
12	P. Barry	181	46	O. D. Schein	113	80	D. A. H. Laidlaw	93
13	J. C. Javitt	180	47	K. Pesudovs	113	81	W. A. Lyle	92
14	W. Drexler	164	48	S. Schmitz	112	82	B. G. Busbee	92
15	J. B. Dickey	163	49	O. D. Schein	111	83	P. G. Ursell	91
16	J. C. Javitt	163	50	A. Pollack	110	84	K. R. Wilhelmus	91
17	J. J. Miller	162	51	B. J. Shingleton	110	85	J. C. Javitt	91
18	M. H. Brenner	162	52	W. B. Applegate	110	86	S. T. Simmons	90
19	E. S. West	161	53	H. V. Gimbel	109	87	G. D. Gilliland	88
20	E. P. Steinberg	156	54	P. Coonan	109	88	K. M. Brady	88
21	K. Hayashi	154	55	J. P. Gills	108	89	P. G. Montan	88
22	J. A. Savage	153	56	G. S. Rubin	107	90	T. W. Samuelson	88
23	N. M. Holekamp	150	57	J. M. Tielsch	107	91	J. R. Shepherd	88
24	Y. Nagaki	146	58	L. M. Cobo	107	92	P. G. Montan	87
25	J. Alio	141	59	R. R. A. Bourne	106	93	E. Borasio	87
26	M. Lundstrom	141	60	R. M. Kershner	105	94	B. E. Klein	86
27	R. H. Harwood	140	61	P. Courtney	105	95	H. B. Dick	86
28	B. Seitz	135	62	L. J. B. McGuigan	105	96	B. A. Blodi	86
29	P. Desai	135	63	P. Desai	104	97	H. V. Gimbel	85
30	M. Leyland	132	64	J. M. Parel	104	98	S. J. Kim	85
31	R. F. Steinert	132	65	K. M. Colleaux	103	99	J. L. Weiss	85
32	H. V. Gimbel	129	66	H.R. McDonald	103	100	J. C. Javitt	85
33	J. J. Wang	128	67	P. J. T. Chiam	102			
34	J. C. Javitt	128	68	T. Oshika	102			

ESCRS: European Society of Cataract & Refractive Surgeons.

the 100 most-cited papers relevant to cataract surgery identified on Thomson Reuters Web of Knowledge through extensive search.

MATERIALS AND METHODS

A comprehensive literature search was performed to identify the 100 most-cited relevant papers from 1950 to 2016 on the Thomason Reuters Web of Science (Science Citation Index Expanded) on 7th December 2016. The search terms were “cataract surgery”, “phacoemulsification”, “manual small-incision cataract surgery” or “MSICS”, “extracapsular cataract extraction” or “ECCE”. No limits were applied in the search and the results were ranked according to the citation frequency. Before further analysis of the papers, the authorships, titles, year of publications, countries, number of citations in total,

number of citations in the latest 5y, average citation number per year (ACY), journals of publication, journals’ IF, main themes, and institutions of origin were recorded.

Statistical Analysis Pearson’s correlation analysis was performed to evaluate the correlation between the published year and the number of citations, including the total citations, latest 5y citations and ACY. The correlations between journal’s IF and the number of total citations were also assessed. The analyses were performed with SPSS 20.0. *P* values less than 0.05 in two-sides were considered to be statistically significant.

RESULTS

Citations, Publication Years The Web of Science literature search returned 10 761 full-length papers. The 100 most-cited papers and their numbers of citations are shown in Table 1.

Influential papers on cataract surgery

The number of citations ranges from 85 to 281 for the top-100 papers, with a mean of 126. The oldest paper on the list was written by Irvine^[23] in 1953 ranking fourth, whereas the other 99 papers were all published since 1980, with the 1990s being the decade with the largest number of publications as well as the most citations (Table 2, Figure 1).

Topics The topics listed in the top 100 papers were wide-ranging and covered almost every aspect of cataract surgery; however, there are several themes commonly seen in many of the papers. The most common topics are postoperative complications, clinical outcomes and the surgical techniques (Table 3). Among them, the 45 complication-associated papers contribute to the most citations of 5768. It is obvious that endophthalmitis is the most hot theme within various complications, such as post-capsular opacification, astigmatism or aberration. Not surprisingly, the top 2 most-cited papers on the list also focused on the prophylaxis against endophthalmitis^[24-25]. These results suggest that endophthalmitis is one of the research hotspots attracting many ophthalmologists because of its terrible prognosis (Table 3)^[26-28].

Authors Because most papers have more than one author, it is hard to identify the author of each paper who makes the leading contribution. Thus, we assume that the primary contributor is the author ranking in the first position^[29]. We find that many authors are represented multiple times on the list, including J. C. Javitt, P. Desai, O. D. Schein, E.P. Steinberg, H. V. Gimbel, P. G. Montan and K. Hayashi (Table 4).

Countries Fourteen countries contribute to the 98 most-cited papers of cataract surgery. The top three countries of origin are the USA, UK and Japan, followed by Germany, Sweden, Canada, the Netherlands, Spain, Hungary, Austria, Australia, Israel, China and India (Table 5). Two papers focusing on the prophylaxis were done by the European Society of Cataract & Refractive Surgeons (ESCRS) and therefore excluded from the analysis of the countries.

Institutions Totally, 68 independent institutions of the first authors were credited among the 100 papers, with some listed in more than one single paper (Table 6). The institution that contribute the most citations was Johns Hopkins University with 1527 citations, and followed by Harvard Medical School with 621 citations.

Journals Moreover, the top-100 list involves 14 journals (Table 7) with the number of papers per journal ranging from 1 to 35. The most-represented journal is *Ophthalmology* with 35 papers, followed by *Journal of Cataract and Refractive Surgery* and *American Journal of Ophthalmology* with 24 and 13 papers respectively. These 3 journals also contribute the most citations, precisely 4207, 2917 and 1771.

Association The latest 5y citations and ACY were found to be significantly related with the published year (5y citations: $r=0.615$, $P<0.001$; ACY: $r=0.657$, $P<0.001$), whereas no association between the total number of citations and published

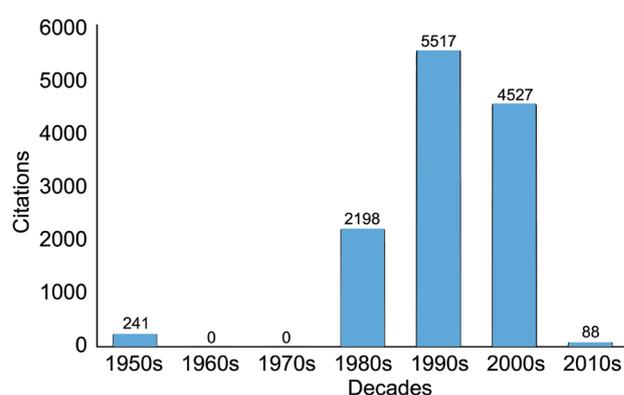


Figure 1 Citations of decades.

Table 2 Publication dates

Decades	No. of papers	Total citations
1950s	1	241
1960s	0	0
1970s	0	0
1980s	20	2198
1990s	45	5517
2000s	33	4527
2010s	1	88

Table 3 Most popular topics

Topics	No. of papers	Total citations
Complications	45	5768
Surgical techniques	17	2191
Clinical outcomes	16	1960
Glaucoma	5	583
Epidemiology	4	501
Anesthesia	4	395
Preoperative tests	2	322
Cost-effect	2	248
Pathogenesis	1	150
Uveitis	1	124
Smoking	1	117
Car accident	1	119
Keratotomy	1	93

Table 4 Top 10 authors with most citations

Name	No. of papers	Total citations
J. C. Javitt	5	647
P. Desai	3	463
O. D. Schein	3	433
E.P. Steinberg	2	367
H. V. Gimbel	3	323
P. G. Montan	3	297
K. Hayashi	2	279
M. Taban	1	256
T. A. Ciulla	1	242
S. R. Irvine	1	241

Table 5 Countries of publications

Country	No. of papers	Total citations
USA	58	7166
UK	14	1783
Japan	4	527
Germany	4	448
Sweden	4	438
Canada	4	426
Netherlands	2	282
Spain	2	260
Hungary	1	186
Austria	1	164
Australia	1	128
Israel	1	110
China	1	97
India	1	94

Table 6 Institutions of publications

Institutions	No. of papers	Total citations
Johns Hopkins University	11	1527
Harvard Medical School	5	621
Georgetown University Medical Center	4	562
ESCRS	2	462
Moorfields Eye Hospital	3	417
Royal College of Ophthalmologists	3	344
Gimbel Eye Centre	3	323
St Eriks Hospital	3	297
University of California, San Francisco	2	286
Hayashi Eye Hospital	2	279

Table 7 Publication journals

Journals	No. of papers	Total citations	IF
<i>Ophthalmology</i>	35	4207	6.75
<i>Journal of Cataract and Refractive Surgery</i>	24	2917	3.02
<i>American Journal of Ophthalmology</i>	13	1771	3.831
<i>Archives of Ophthalmology</i>	10	1422	4.34
<i>British Journal of Ophthalmology</i>	4	593	3.036
<i>JAMA</i>	3	346	37.684
<i>EYE</i>	3	331	2.213
<i>New England Journal of Medicine</i>	1	209	59.558
<i>Investigative Ophthalmology & Visual Science</i>	1	113	3.427
<i>Journal of Refractive Surgery</i>	1	186	3.314
<i>Ophthalmic Surgery and Lasers</i>	2	176	1.892
<i>Canadian Journal of Ophthalmology</i>	1	103	1.46
<i>Graefes Archive for Clinical and Experimental Ophthalmology</i>	1	104	1.991
<i>Lancet</i>	1	93	44.002

year was found ($r=0.045$). The Pearson's correlation analysis also shows that IF of journals had no significant effect on the number of total citations.

DISCUSSION

The most-cited paper is "Prophylaxis of postoperative endophthalmitis following cataract surgery: results of the ESCRS multicenter study and identification of risk factors" conducted by ESCRS Endothalmitis Study Group and published in the *Journal of Cataract and Refractive Surgery* in 2007^[24]. This study focuses on investigating the risk factors and effects of antibiotic prophylaxis on the incidence of endophthalmitis after cataract surgery. This work is a prospective randomized partially masked multicenter study on cataract surgery led by ESCRS and suggests that prophylaxis, precisely the use of intracameral cefuroxime at the end of surgery, would reduce the incidence of postoperative endophthalmitis. However, the application of clear corneal incision (CCI) and silicone intraocular lens (IOLs) would increase the incidence of endophthalmitis after cataract surgery compared with the scleral tunnels and acrylic IOLs. Interestingly, the second most-cited paper on the list, entitled "Acute endophthalmitis following cataract surgery: a systematic review of the literature", is also about endophthalmitis written by Taban *et al*^[25] in 2005. This systematic review reports the incidence rate based on an extensive literature search and indicates that the increasing rate of postoperative endophthalmitis may be caused by the popular application of sutureless CCI. This conclusion coincides with the results from the former ESCRS study. Impressively, the topic of the third most-cited paper is also about endophthalmitis after cataract surgery. This review was written by Ciulla *et al*^[30] and its conclusions supported that the use of antibiotic prophylaxis could decrease the incidence rate of endophthalmitis after cataract surgery^[31].

There are common themes among many of the papers on this list (Table 3). On basis of our results, we rank the relative importance placed on the various research areas by cataract surgeons from 1950 to now. Postoperative complications, especially endophthalmitis, are the most attractive research areas of cataract surgery with 5768 citations, followed by the description of application of new surgical techniques, and the evaluation of surgical outcomes, with 2191 and 1960 citations respectively. These topics are most commonly seen in the research fields on cataract surgery.

Except two studies performed by the ESCRS, which includes many European countries^[24,32], the rest 98 papers are attributed to a total of 14 countries. Among them, the USA with 58 papers ranks top undoubtedly with 7166 citations, followed by the UK with 14 papers, Japan with 4 papers, Germany with 4 papers, Sweden with 4 papers, Canada with 4 papers and the Netherlands with 2 papers. These seven countries are all from the developed world and have devoted high expenditure

to the health care systems, which may contribute to their high performances in the rank list. Concerning the institutes of origin, the most commonly seen institutes were Johns Hopkins University and Harvard Medical School, with 1527 and 621 citations respectively. It might be owed to the Wilmer Eye Institute and the Massachusetts Eye & Ear Infirmary Affiliated to Johns Hopkins and Harvard. These two world famous eye research centers have done many excellent works, which impress the global ophthalmological community. The institutes that followed were the Georgetown University with 562 citations, ESCRS with 462 citations, Moorfields Eye Hospital with 417 citations, Royal College of Ophthalmologists with 344 citations, Gimbel Eye Centre with 323 citations, St. Eriks Hospital with 297 citations, UCSF with 286 citations and Hayashi Eye Hospital with 279 citations. It is very impressive to note that the Canadian Family-owned Gimbel Eye Centre outperforms many famous large public eye centers. The three papers contributed by Gimbel Eye Centre were all written by the famous ophthalmologist Prof. Gimbel^[33-35], who is known as the cofounder of the continuous curvilinear capsulorhexis (CCC) with Thomas Neuhann. He also first reported the technique of Divide and Conquer nucleofractis Phaco in one of his 3 papers included in the top-100 list^[34].

As was noted in our results, the top-100 list only concerns 14 journals. The journal with the largest number of influential papers is *Ophthalmology*, with 35 articles published between 1983 and 2011. These articles cover a wide range of topics, such as postoperative complications, surgical outcomes and surgery technical improvements. This journal also contributes the most citations of 4207. The journal that follows is *Journal of Cataract and Refractive Surgery* with 2917 citations. This journal also contributed the most cited paper in the top-100 list. It is striking that these two journals contributed more than half in the number of the total citations. The latest papers of these two journals included in the list were published in year 2011 and 2009 respectively.

The author contributing the most citations of 647 and the one providing the most papers are Prof. Javitt^[36-39]. The top 2 to 5 authors with the most citations are P. Desai with 463 citations, O. D. Schein with 433 citations, E. P. Steinberg with 367 citations and H. V. Gimbel with 323 citations.

According to our analysis, most influential papers were published in 1980s and 1990s. Interestingly, no papers published in the decades of 1960s and 1970s are included in our study. Though this result may be caused by varied factors, we believe that the appearance and development of Phaco in cataract surgery may be the main reason. In 1967, Kelman^[40] firstly applied Phaco in cataract surgery, and now it has become the most popular surgical type in this field. However, in the first few years, the high cost of Phaco machines and long-time training period for junior surgeons might strongly restrict the practicability and promotion of this revolutionary

surgical technique. So we conjecture that most of the papers published in 1960s and 1970s are irrelevant to Phaco and are thus less likely to be cited in the following decades.

The result of the Pearson correlation analysis showed no significant correlation between the published year and the total number of citations, while we observed that the latest 5y citations and ACY were significantly associated with the published year. It may be owed to that people are much more willing to cite the recent papers with the newest and hottest research achievements published on them. In our observation, the journals' IF had no meaningful effect on the total citations. It may be explained that the involved journals in our study were all with high quality in their professional fields.

Though we manage to identify the 100 most influential articles by ranking the citations, our bibliometric analysis may be restricted by some other factors, such as self-citation, and journal bias. However, the present study pays little attention to the control of these factors. There are also many phenomena that can impact citation analysis, including obliteration by incorporation and incomplete citing. These factors may restrict the applicability of this study.

To our knowledge, this is the first study to identify the 100 most influential papers about cataract surgery and provide ophthalmologists with a comprehensive bibliometric analysis. This study manages to provide valuable information about the development of cataract surgery between 1950 and 2016, and serves as a reference source in the arena of cataract surgery for ophthalmologists involved in further development of this surgery.

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