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The Top 100 Cited Articles in Urethral Reconstruction

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OBJECTIVE	To examine the most cited literature in urethral reconstruction, review types of work published, and observe research trends.
METHODS	The Web of Sciences Sci-Expanded Index was used to conduct a search for urethral reconstruction. References were assessed for relevance to urethral reconstruction by 2 independent reviewers and a final list of the top 100 articles ranked by citation count was obtained. For each article, citation count, publication date, corresponding author, origin institution, origin country, topic area, study design, level of evidence, and origin journal were collected.
RESULTS	The mean citation count per publication was 108 (median = 94.5; range = 69-366, SD = 43) with a total of 10,874 citations for all papers since 1970. The top 100 articles were published between 1973 and 2011, came from 19 different countries and 16 different journals. Nearly half were case series and most studies were Level III evidence or lower. The United States was the largest contributor to the top 100 with 56 publications, followed by Italy (14), England (12), and Egypt (7). "Outcomes of surgical treatment for urethral stricture disease" was the most prevalent topic area comprising 55 articles in the top 100, with most articles including descriptions or outcomes of novel surgical techniques.
CONCLUSION	In this study, we discovered that the most cited literature in the field of urethral reconstruction is singularly focused and lacking in high levels of evidence. The top 100 cited articles originate primarily from the United States, focus on short-term outcomes after surgical treatment for urethral stricture disease, and are predominantly case series. UROLOGY 00: 1–7, 2019. © 2019 Elsevier Inc.

Urethral reconstruction has undergone remarkable innovation and change: more than 300 methods have been described for stricture treatment, with an exponential increase in the literature over the past 5 decades.^{1,2} Given that urethral stricture disease (USD) is associated with significant cost and morbidity, increasing attention and study is warranted. USD led to an estimated 1.2 million outpatient visits between 2002 and 2007³ and more than 200,000 ambulatory surgery visits between 1994 and 1996.⁴ Associated healthcare costs in the US have been estimated at \$175-207 million yearly between 1994 and 2000, with the total cost per patient with USD averaging close to \$10,000.^{5,6}

The oldest literature of urethral surgery dates back to 1827, when treatment was debated by surgeons George Maciwillan and MW Andrews in the Medico-Chirurgical Review.⁷ In 1872, the term *urethroplasty* first emerged in

the context of urinary fistula care.⁸ The term "urethral reconstruction" originated in 1954 in a discussion of experimental treatments for hypospadias.⁹ Almost 200 years after urethral strictures were being treated with "bougies" by Maciwillan and Andrews, new research and experimental treatments came to the forefront.¹⁰ Studies examining the top 100 articles in various fields have helped to investigate literature redundancy, assess research quality, highlight trends in research interests, and/or explore the chronological evolution of scientific publishing.¹¹ To our knowledge, no such study has been done on the topic of urethral reconstruction. We aim to provide historical context and explore the landscape of publications that have been most popular in urethral reconstruction since 1970 as well as identify thought leaders and topics that are the most influential in urethral reconstruction.

METHODS

Article Selection

To identify the most frequently cited articles in urethral reconstruction, we utilized a previously published bibliometric methodology.¹² We identified our initial references from the Web of Sciences Sci-Expanded Index by using the following search

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query: (“urethral stricture” OR “urethral stricture disease” OR “urethral disease” OR “urethroplasty” OR “urethral trauma” OR “urethral stones” OR “urethral reconstruction” OR “urethral pain”), performed on 4/7/2019 (Web of Science Core Collection, Clarivate Analytics). We included original investigations and excluded non-English articles. To focus on literature most pertinent to current practice, we limited our search to articles published in 1970 or later. Our initial search resulted in 5367 articles; after application of inclusion and exclusion criteria, 3333 publications remained (Fig. 1). Two independent reviewers screened titles and abstracts for relevance to urethral reconstruction yielding our final list of the top 100, which were ranked by number of times cited. This final top 100 reference list was used for bibliometric analysis.

Bibliometric Analysis

For our bibliometric analysis, we analyzed data on citation count, publication date, origin country, origin institution, corresponding author, topic area, study design, level of evidence, and origin journal. In articles with more than 1 associated country or institution, the country and institution of the corresponding author was used. Main topic areas identified included: outcomes of surgical treatment for USD, outcomes of hypospadias repair, outcomes of urethrotomy, guidelines in urethral reconstruction, epidemiology of urethral reconstruction, economics of urethral reconstruction, and basic science principles of urethral reconstruction. Study designs included: case series, prospective cohort, randomized control trial (RCT), survey, retrospective cohort, retrospective case control, and cross-sectional. Levels of evidence included: IA, IB, IIA, IIB, III, and IV. Definitions for each study design and level of evidence can be found in [Appendix 1](#).^{13,14} Topic area, study design, and level of evidence for each article was assessed and agreed upon by consensus by

several authors (AL, AC, and BB). After utilizing the Web of Science citation tool to perform composite self-citation analysis, only 2.7% of total citations were self-citations; therefore, we did not perform a separate article-level self-citation analysis. The top authors list took into account multiple authors on a single paper; a single paper may have multiple leading researchers involved.

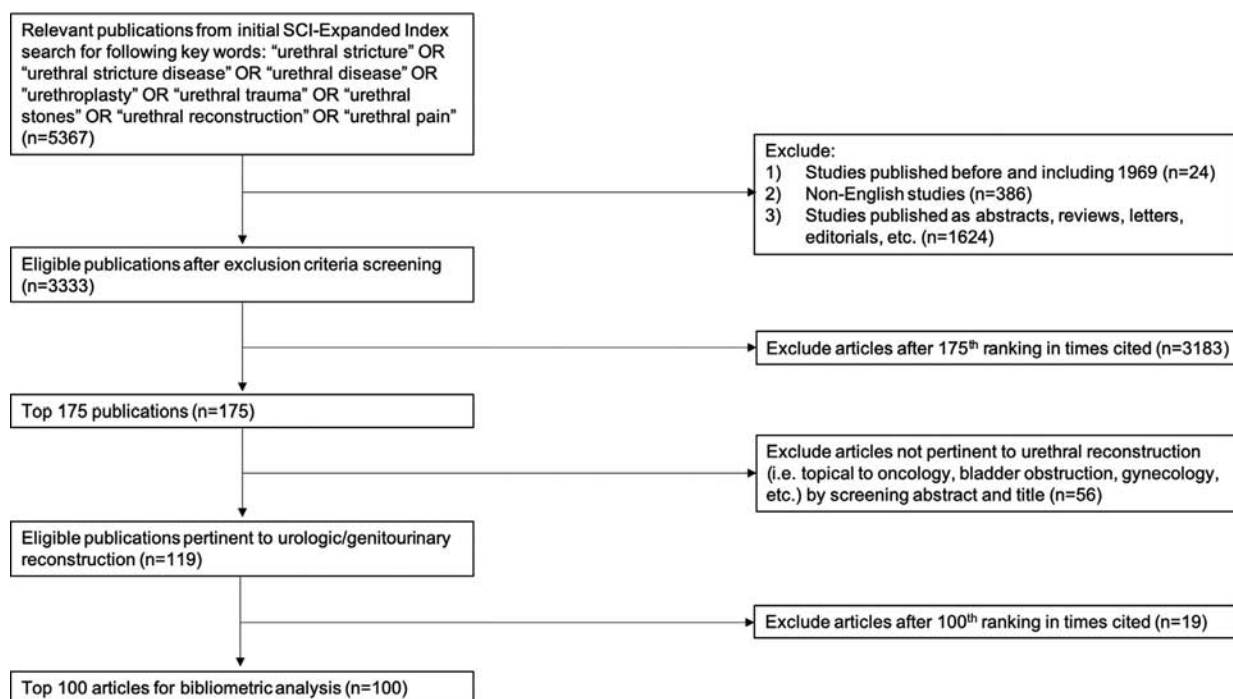
Summative statistics including mean citation count and initial search query yield were done. Mean citation count was defined as the total number of citations for the top 100 articles divided by the number of included articles. Initial count was defined as the number of articles from the first query of the databases of interest (Pubmed, Web of Science, etc.) before inclusion/exclusion criteria were applied.

Simple statistics were done and graphics were created using Microsoft Office (Redmond, WA) and Clarivate Analytics (Philadelphia, PA), respectively.

RESULTS

In reviewing the top 100 articles, the total sum of times cited across all articles from 1970 to present was 10,874. After adjusting for self-citation, there were a total of 10,579 citations from 4324 articles for all papers (2.7% of total citations were self-cited) with a mean citation count per publication of 108 (median: 94.5; range: 69-366; SD: 43). Peak years in terms of citations were in 2011, 2014, and 2015 during which there were 868, 894, and 863 total citations, respectively (Fig. 2).

All articles that constitute the top 100 in urethral reconstruction were published between 1973 and 2011. The most productive years in terms of contribution to the top 100 were in 1996 and 2007 during which 9 articles were produced in each year. Between 1973-1976, 1976-1983, 1983-1990, and 1990-1992,



SCI-Expanded: science expanded

Figure 1. Exclusion and inclusion criteria and selection process of top 100 cited articles. SCI-Expanded, science expanded.

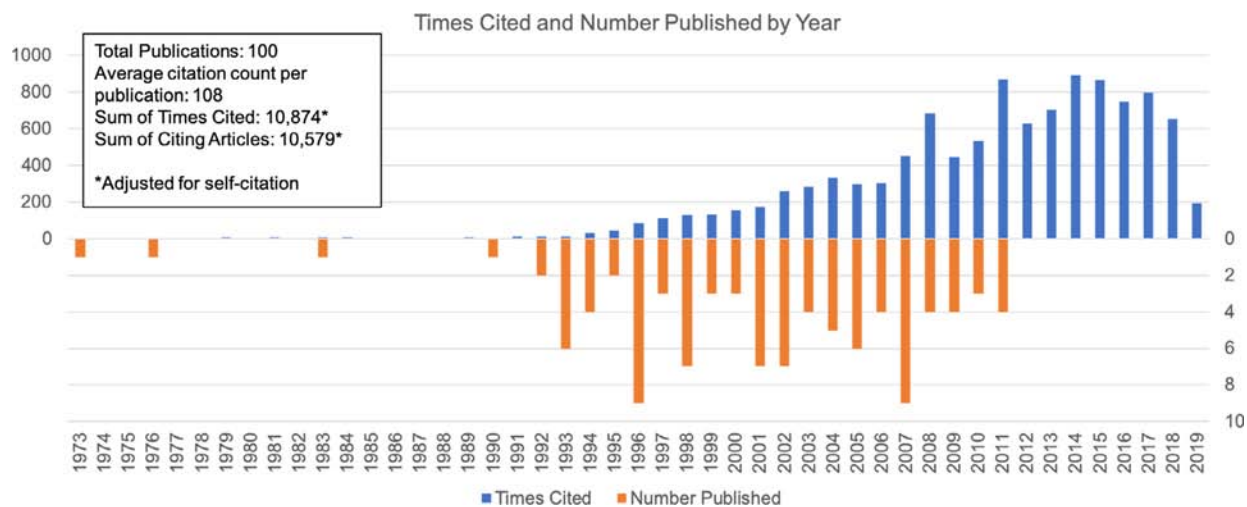


Figure 2. Composite citation count and number published in top 100 cited articles over time. (Color version available online.)

there were no papers published that factored into the top 100 (Fig. 2).

The top 100 publications in urethral reconstruction were from 19 different countries. The United States was the largest contributor with 56 total publications, followed by Italy (14), England (12), and Egypt (7). Notably, the top 5 most represented institutions were associated with the highest country contributors. University of California, San Francisco was the greatest contributor with 15 articles, followed by University of Florence with 7 articles. Harvard Medical School, University of Texas Southwestern Medical Center and University College London all contributed 5 articles in the top 100 each. Most corresponding authors were also associated with top institution and country contributors with JW McAninch being the most prolific author with 13 articles. A Atala, G Barbagli, and AR Mundy followed next with each having 9 articles on the top 100 list. Authorship involving multiple top contributors for a single paper was common with 25% of the top 100 articles having 2 or more of the top 10 authors included as part of the author list (Appendix 2).

By subject area, “outcomes of surgical treatment for USD” was the most represented topic area comprising 55 articles in the top 100. Subtopics under “outcomes of surgical treatment for USD” included: innovations in graft type (ie, buccal mucosa grafts, intestinal submucosa grafts), innovations in flap procedures (ie, penile fasciocutaneous skin flaps, free sensate osteocutaneous flaps), comparison of techniques in stricture management (ie, anastomotic urethral reconstruction vs dilation), and complications after urethral reconstruction. This was followed by “outcomes of hypospadias repair” with 15 articles and “basic science of urethral reconstruction” with 11 articles (Fig. 3A). In terms of study design, 49% of the top 100 papers were descriptive case series, 12% were retrospective cohort studies, 9% were basic science studies, 8% were prospective cohort studies, and 5% were RCTs. All other study designs constituted the remaining 17% (Fig. 3B). Most evidence was level III (68%), followed by IIB (19%), IIA (6%), IB (6%), and IV (1%). No studies met level IA level of evidence (Fig. 3C).

The top 100 articles were published in 16 different journals. Sixty-five percent of all papers were published in the *Journal of Urology*. Other journals each comprised less than 10% of the total top 100 list with *European Urology* and *Urology* tying for

second at 7% each (Fig. 3D). A detailed list of the top 100 cited articles can be found in Appendix 3.

Within the top 10 articles, we found a predominance of studies on direct evaluation of surgical techniques for managing USD. These papers either presented procedural innovations to the field or directly compared existing treatment modalities to best optimize postoperative clinical outcomes (Table 1).

COMMENT

The quantity of literature in urethral reconstruction has increased in its citation count in the past 30 years. The United States has generated the greatest share of the top 100 articles and mostly on topics regarding outcomes after surgical management of USD. Notably, most studies are observational case series with low levels of evidence. Only 8% were prospective cohort studies and 5% RCTs. No studies in the top 100 articles are level IA evidence. The most cited work often involved collaboration between leading academic authors with 25% of the top 100 articles being written by 2 or more of the top 10 authors. Combining data from different centers and sharing similar research goals may help overcome the limitations of individual case series dominating the historic literature.

Bibliometric analyses have been conducted across several disciplines including plastic surgery, emergency medicine, and nephrology as a way to objectively survey the high impact articles in a given field.¹⁵⁻¹⁷ Our findings for urethral reconstructive yielded a mean citation count of 108. Similar bibliometric studies for general urology, urologic emergencies, and primary hypospadiology yielded mean citation counts of 892, 26, and 76, respectively.^{12,18,19} Our mean citation count is below that of general urology which may be secondary to the subspecialty topic under consideration.¹² However, the greater mean citation count compared to urological emergencies and hypospadiology may suggest that the field of urethral reconstruction is generating an overall increased body of research relative to those fields. It may also suggest

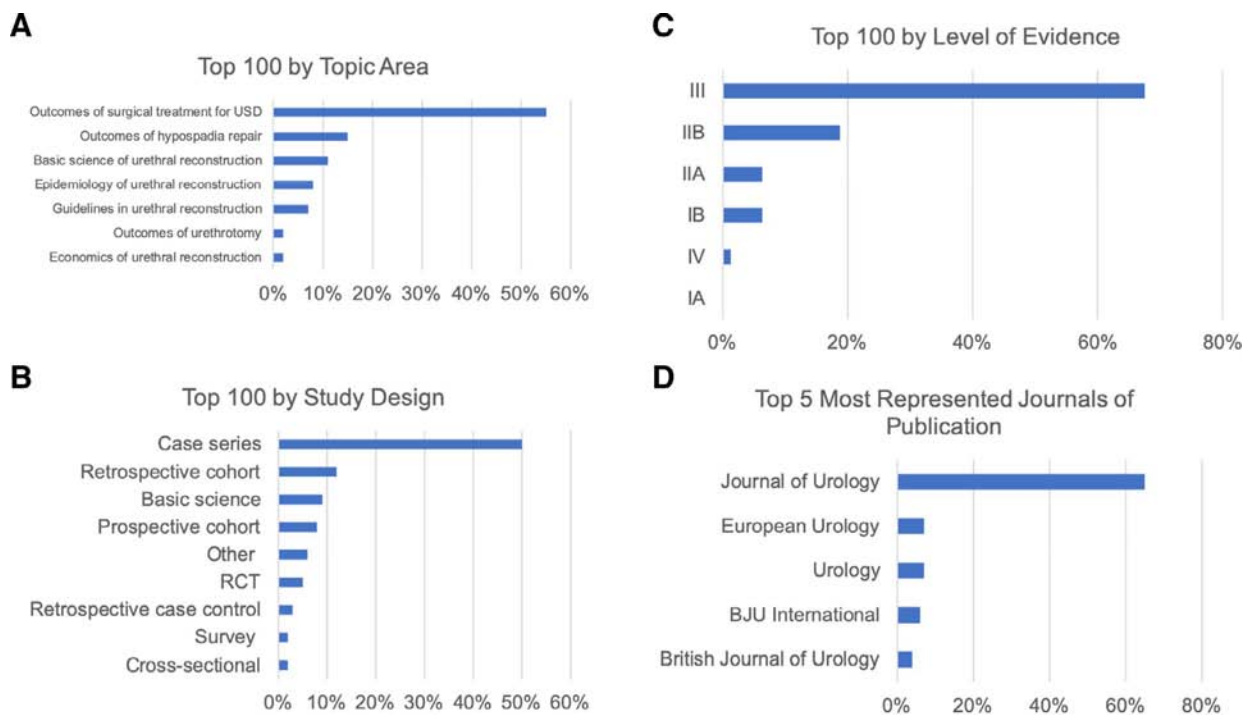


Figure 3. Content, study design, level of evidence, and journal of publication of top 100 cited articles. (Color version available online.)

increased differences in expert opinion within urethral reconstruction generates increased yield of active research. Like these prior studies, the present study found the United States to be the greatest contributor of top cited articles. The topical focus on surgical techniques and outcomes also remained consistent between our study and the bibliometric analyses on general urology and hypospadiology, suggesting similar scopes of research interest across the fields.

A significant proportion of the top 100 articles were dedicated to USD surgery outcomes and were presented as case series with lower levels of evidence. This may be because consensus is not clear on all management practices²⁰; therefore, academicians are still assessing outcomes of various therapeutic modalities. This mirrors the general pattern of innovation in surgery whereby incremental innovations are assessed, disseminated and then adopted widely based off individuals' experience.^{21,22} Urethral reconstruction may presently face challenges in research scope by availability of funding, willingness of patients or physicians to participate in various trials, difficulty in overcoming care by expert opinion, and an overall lack of evidence-based medicine.^{23,24} The difficulty in amounting large case volumes to execute robust comparative trials is a particular challenge germane to reconstructive urology.^{10,25} By identifying the emergent academic landscape of urethral reconstruction, this study informs the appropriate current emphasis on clinical judgment when managing urethral strictures in the absence of evidence-based guidelines.

A transition toward urethral reconstruction research with higher levels of evidence may emerge as

reconstruction techniques become more canonical. As any discipline matures, associated research typically progresses to higher quality evidence and more robust studies.²⁶ A higher level of research, in turn, improves clinical management as practice is dictated more by evidence and less by circumstantial factors. By exploring the key trends in research concerning urethral reconstruction, this study provides insight into improvement areas to facilitate more systematic management of urethral strictures. Looking forward, the ideal state of research in urethral reconstruction will involve more rigorous evidence-based trials, increased collaboration, and a greater variety in the topics explored. Future collaboration via groups such as the Trauma and Reconstructive Network of Surgeons or Trauma and Reconstructive Urology Working Party of the European Association of Urology Young Academic Urologists may enable development of well-powered RCTs.^{27,28} For subjects in which rare conditions must first be identified for potential trial inclusion, integrated national electronic healthcare data offers promise.²⁹ Furthermore, the adoption of complex digital computing within medicine may allow for simulated randomized clinical trials, reducing cost, and drastically reducing patient risk.³⁰

Limitations of this study include that we assume that citation count serves as a proxy for article value. We did not account for whether the citation was positively portrayed or negatively critiqued in the citing article.¹² Citation count may more closely approximate excitement or "buzz" around a given topic rather than serve as a true marker for quality, innovation or impact. Citation count is also, by nature, a time-delayed metric whereby recently published articles are not accurately represented because

Table 1. Top 10 cited articles

Authors	Date	Title	Journal	Institution	Topic Areas	Study Design	Level of Evidence	Times Cited
W. Snodgrass	1994	Tubularized, incised plate urethroplasty for distal hypospadias	Journal of Urology	Methodist Children's Hospital	Outcomes of hypospadias repair	Case series	III	366
A. Raya-Rivera, D. R. Esquiliano, J. J. Yoo, E. Lopez-Bayghen, S. Soker and A. Atala	2011	Tissue-engineered autologous urethras for patients who need reconstruction: an observational study	Lancet	Wake Forest University	Basic science of urethral reconstruction	Case series	III	236
F. Chen, J. J. Yoo and A. Atala	1999	Acellular collagen matrix as a possible "off the shelf" biomaterial for urethral repair	Urology	Harvard Medical School	Basic science of urethral reconstruction	Basic science	N/A	227
R. A. Burger, S. C. Muller, H. Eldamanhoury, A. Tschakaloff, H. Riedmiller and R. Hohenfellner	1992	The buccal mucosal graft for urethral reconstruction - a preliminary-report	Journal of Urology	Johannes Gutenberg University, Germany	Outcomes of surgical treatment for USD	Case series	III	189
R. A. Santucci, G. F. Joyce and M. Wise	2007	Male urethral stricture disease	Journal of Urology	Wayne State University School of Medicine	Epidemiology of urethral reconstruction	Epidemiologic	N/A	187
C. F. Heyns, J. W. Steenkamp, M. L. S. De Kock and P. Whitaker	1998	Treatment of male urethral strictures: Is repeated dilation or internal urethrotomy useful?	Journal of Urology	University of Stellenbosch and Tygerberg Hospital, South Africa	Outcomes of urethrotomy	RCT	IB	176
J. W. Steenkamp, C. F. Heyns and M. L. S. deKock	1997	Internal urethrotomy versus dilation as treatment for male urethral strictures: A prospective, randomized comparison	Journal of Urology	University of Stellenbosch, South Africa	Outcomes of surgical treatment for USD	RCT	IB	175
R. A. Santucci, L. A. Mario and J. W. McAninch	2002	Anastomotic urethroplasty for bulbar urethral stricture: Analysis of 168 patients	Journal of Urology	University of California San Francisco	Outcomes of surgical treatment for USD	Case series	III	159
G. Barbagli, C. Selli, A. Tosto and E. Palminteri	1996	Dorsal free graft urethroplasty	Journal of Urology	University of Florence, Italy	Outcomes of surgical treatment for USD	Case series	III	157
G. Barbagli, E. Palminteri, G. Guazzoni, F. Montorsi, D. Turini and M. Lazzeri	2005	Bulbar urethroplasty using buccal mucosa grafts placed on the ventral, dorsal or lateral surface of the urethra: Are results affected by the surgical technique?	Journal of Urology	University of Florence, Italy	Outcomes of surgical treatment for USD	Prospective cohort	IIB	155

RCT, randomized control trial; USD, urethral stricture disease.

they have not yet had time to amass citation count. These limitations notwithstanding, this study has several strengths. To our knowledge this is the first study to evaluate the top literature in urethral reconstruction and has the potential to set the stage for future research in urethral reconstruction.

CONCLUSION

We found top literature in the field of urethral reconstruction to be singularly focused and lacking in high levels of evidence. The top 100 cited articles originated primarily from the United States, focused on short-term outcomes after surgical treatment for USD and are overwhelmingly designed as case series. We predict that future USD research will continue to be collaborative with higher levels of evidence.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.urology.2019.08.052>.

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Editorial Comment

The authors are to be commended for their attempt to quantitatively characterize the most cited literature in urethral reconstructive surgery by performing a bibliometric analysis. Some favor the use of citations over the peer review process to assess

the impact and quality of research.¹ However, citations are not as objective as one would think due to a number of possible biases that can occur.² Honorary citations stem from the tendency of people to cite their colleagues, trainees, and former mentors. Reciprocal citations occur between authors who tend to cite one another. Papers stemming from collaborative research efforts also create an issue with multiple authors because it treats all authors as having the same level of impact on the manuscript compared to a single author. Authors have been shown to preferentially cite works originating from their own country.³ Thankfully, self-citation is limited in this body of literature (2.7%).

The field of urethral reconstruction is in a relative infancy compared to other disciplines in urology. Many key founders advanced the field of urethral reconstruction by developing innovative surgical techniques. As a result, these groundbreaking authors are well represented in the top 100 articles. Their influence is further extended by the development of fellowship programs with most of their trainees performing the bulk of current research. The top 10 articles certainly pass the “eye test” and are comprised of seminal papers in the field of urethral reconstruction. The lack of manuscripts after 2011 raises another criticism against using citations as a marker of research quality. There is a lead time bias on new, significant manuscripts published in the recent years. Current research must be reviewed, validated, and implemented into practice before it will begin to be cited in the literature despite the possibility of near immediate impact in the field.

The most important finding from this paper is the overall lack of high level evidence and the preponderance of single surgeon case series. We must move beyond the single expert reports and perform a deep dive into urethral reconstruction to better understand the prevention of stricture disease and determine the optimal management for urethral strictures. In the words of Douglas Altman, “We need less research, better research, and research done for the right reasons.”⁴

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