Reference accuracy in spine surgery

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OBJECTIVE The references list is an important part of a scientific article that serves to confirm the accuracy of the authors' statements. The goal of this study was to evaluate the reference accuracy in the field of spine surgery.

METHODS Four major peer-reviewed spine surgery journals were chosen for this study based on their subspecialty clinical impact factors. Sixty articles per journal were selected from 12 issues each of *The Spine Journal*, *Spine*, and *Journal of Neurosurgery: Spine*, and 40 articles were selected from 8 issues of *Global Spine Journal*, for a total of 220 articles. All the articles were published in 2019 and were selected using computer-generated numbers. From the references list of each article, one reference was again selected by using a computer-generated number and then checked for citation or quotation errors.

RESULTS The results indicate that 84.1% of articles have a minor citation error, 4.5% of articles have a major citation error, 9.5% of articles have a minor quotation error, and 9.1% of articles have a major quotation error. *Journal of Neurosurgery: Spine* had the fewest citation errors compared with the other journals evaluated in this study. Using chi-square analysis, no association was determined between the occurrence of errors and potential markers of reference mistakes. Still, statistical significance was found between the occurrence of citation errors and the spine journals tested.

CONCLUSIONS In order to advance medical treatment and patient care in spine surgery, detailed documentation and attention to detail are necessary. The results from this study illustrate that improved reference accuracy is required.

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KEYWORDS reference accuracy; citation error; quotation error; spine surgery; neurosurgery

IN academic manuscripts, authors use references in publications as sources to validate and emphasize research points. Therefore, references lists serve writers, researchers, and readers as a vital source for confirmation of the accuracy of authors' statements.

The number of articles in the field of spine surgery has increased rapidly in the past years.^{1,2} Due to the rapidity of publication, the accuracy of the information published is necessary to understand and to validate research findings. Unfortunately, reference errors in medical literature are common and occur in all specialties.^{3–10} In most cases these errors are trivial, with few impacts on conclusions, but they can still cause misinterpretation and inaccurate data perpetuation and potentially have clinical consequences.⁹ However, to our knowledge, reference error analysis has not been reported in the field of spine surgery, and this was the main motivation that encouraged this study.

Reference errors can be classified as citation or quotation errors, and the incidence of the errors can serve as a

measure of reference accuracy in a manuscript.¹¹ Citation errors consist of inaccuracies in the components of the cited reference that potentially jeopardize the identification of the source. Quotation errors involve inconsistency between the author's assertion and the content of its supporting source. The objective of this study was to quantify the rate of reference errors in the spine surgery literature.

Methods

Four major peer-reviewed spine surgery journals were chosen for this review based on their subspecialty clinical impact factors: *The Spine Journal* (*Spine J*), *Spine* [*Spine* (Phila Pa 1976)], *Journal of Neurosurgery: Spine* (*J Neurosurg Spine*), and *Global Spine Journal* (*Global Spine J*). Journal issues from the year 2019 were evaluated. All the articles from each monthly issue were numbered sequentially, and 5 from each issue were randomly selected using a computer-generated number to determine which articles to include in the study. Articles written for and included in

supplements, editorials, letters to the editor, and personal communications were excluded due to potential bias in the review process. A sample of 220 articles was selected and analyzed: 60 articles per journal from 12 issues each of *Spine (Phila Pa 1976)*, *Spine J*, and *J Neurosurg Spine*, and 40 articles from 8 issues of *Global Spine J*.

From the references list of each article selected, all the references were sequentially numbered, and a computer-generated number was used to randomly select one reference from each article. References to letters to the editor, personal communications, governmental reports, textbook chapters, presentations, and journal articles that were not in English were excluded from the selection. In this case, a further random number was generated, and the resulting reference was examined.

All the articles selected were retrieved and analyzed by three independent investigators. Each referenced article was read completely and thoroughly and compared with the citation and content of the referring article¹¹ by using a standardized checklist to evaluate for citation and quotation errors. All the citations were checked against information retrieved directly from the official website of each journal analyzed. When a discrepancy was found between reviewers, a fourth senior author reviewed the reference and the error status was assigned by the consensus of a panel of four investigators.

Citation errors were categorized as major or minor errors. Major citation errors were considered ones that prevented immediate identification of the source cited.¹² These included incorrect or omitted publication year, journal title, volume number, supplement designation, or inaccurate pagination not overlapping the correct pages. Minor citation errors covered incorrect or omitted issue numbers, misspellings, omissions, errors of punctuation or substitutions in the authors' names or the title, or incorrect pagination that overlapped the correct pages.^{10,11,13}

Furthermore, quotation errors were classified as major or minor errors. Major quotation errors were determined to occur when the content of the original article failed to substantiate, contradicted, or was unrelated to the authors' contention.^{3,8,13} Minor quotation errors included oversimplification, incorrect measurement numbers, conclusions not reached by the authors of the cited reference, and indirect referencing, and the error was noted as minor if the authors' assertion, although inaccurate, preserved the meaning of the original article.^{3,8,13}

All citation and quotation errors were recorded in a Microsoft Excel file; if there were citation and quotation errors in the same reference, both errors were counted separately, but if a reference with a citation error was quoted several times, it was counted just as one error. All quotations related to the same reference were checked, but if there was a minor and a major quotation error, just the major error was counted. In order to calculate the overall error rates, no more than one citation and one quotation error per article were counted. The following items were recorded: the number of authors, the country of origin of the first author, the journal in which the article was published, the year of publication of the selected references, and the length of the bibliography for each selected article in order to evaluate if those variables are related to the error rate.¹³

Statistical Analysis

Data were collected and transferred for analysis to SPSS 26.0 for Windows (IBM Corp.). A chi-square test was used to analyze the association of the occurrence of citation and quotation errors with the following factors: the journal in which the article was published; the official language of the country of origin of the first author (English vs non-English); the number of authors (≤ 4 or > 4 authors); the length of the bibliography (1–15, 16–30, 31–45, or > 45 entries); the year of publication of the reference (≥ 2014 or < 2014).¹³ All statistical tests were computed at the 95% level of confidence.

Results

A total of 220 articles from the year 2019 journal issues were analyzed. Of the total articles verified, 197 (89.6%) had at least one citation or quotation error—33 (15%) had both citation and quotation errors, 8 (3.6%) had only quotation errors, and 156 (70.9%) had only citation errors. The total number of articles with citation errors, independent of quotation errors, was 189 (85.9%)—10 articles (4.5%) had major citation errors and 179 (81.4%) had only minor citation errors. Forty-one (18.6%) articles had quotation errors, of which 20 (9.1%) were major errors and 21 (9.5%) were minor errors (Tables 1 and 2).

Considering that a large proportion of minor citation errors were attributed to mistakes on the issue numbers, the proportion of citation errors was also calculated for the case when issue number errors were disregarded. In this scenario, 68 (30.9%) articles with at least one citation or quotation error were found—7 (3.2%) articles had both citation and quotation errors, 34 (15.5%) articles had only quotation errors, and 27 (12.3%) had only citation errors (Table 1). From this perspective, the most common type of citation error would be mistakes in punctuation or substitutions in the authors' names, responsible for 17 of 39 errors (43.6% of all citation errors counted, disregarding issue number as a mistake) (Table 3).

The overall rate of citation errors was 85.9%, and 5.3% (10/189) of these articles had major errors, while 2.8% had both major and minor errors in the same article. The most common type of citation error was an incorrect or omitted issue number (82% of all citation errors counted), followed by errors of punctuation or substitutions in the authors' names (17/217 [7.8%] of all citation errors counted), both of which were considered minor errors in our study (Table 3). The most common type of major citation error was the inaccuracy or omission of the supplement designation (45.4% of all major errors and 2.3% of all citation errors counted) (Table 3). Twenty-five citations (11.3% of all citations) had more than one error, and 4 citations (1.8%) had more than two errors.

The overall quotation error rate was 18.6%, of which 48.8% (20/41) were major quotation errors, in which the content of the original article failed to substantiate, contradicted, or was unrelated to the authors' contention (Tables 1 and 3). All 4 of the journals analyzed had major quotation errors, and the rates ranged from 7% to 12% of all the quotations assessed in the issues studied. The minor quotation error rate ranged from 3% to 17.5%. Tables

TABLE 1. Overall number of articles with citation and/or quotation errors from all the journals separated by error type, considering and excluding the issue number as an error

Type of Errors	No. of Articles, N = 220	No. of Articles, Disregarding Mistakes or Omissions of Issue No. as an Error; N = 220
Articles w/ citation & quotation errors	33 (15)	7 (3.2)
Articles w/ only citation errors & no quotation errors	156 (70.9)	27 (12.3)
Articles w/ only quotation errors	8 (3.6)	8 (3.6)
Articles w/ at least 1 citation or quotation error	197 (89.6)	68 (30.9)
Articles w/ no error	23 (10.4)	152 (69.1)
Articles w/ citation errors independent of quotation errors	189 (85.9)	34 (15.5)
Articles w/ major citation errors independent of quotation errors	10 (4.5)	10 (4.5)
Articles w/ only minor citation errors independent of quotation errors	179 (81.4)	24 (11.0)
Articles w/ quotation errors independent of citation errors	41 (18.6)	41 (18.6)

Articles with only quotation errors means that they do not have any other type of error besides the quotation error, whereas articles with quotation errors independent of citation errors means that they have some type of quotation error, whether or not the article also has a citation error. The same distinction between “only” and “independent of” applies to articles with citation errors. Numbers in parentheses designate percentage of articles.

2 and 3 summarize the citation and quotation errors for each journal.

The chi-square test was used to analyze the association between the occurrence of citation and quotation errors and the presence of risk factors that could impact reference accuracy. No statistically significant associations ($p > 0.05$) were found between the citation and quotation errors and the following risk factors: number of authors of the articles; the language of the country of origin of the first author; the length of the bibliography; and the year of publication of the reference analyzed. The association between the citation and quotation errors was also not significant (Table 4).

When the association between the occurrence of citation errors and the journal in which the article was published was tested, a statistical significance ($p < 0.05$) was found. However, no statistical significance was found between the association of occurrence of quotation errors and the spine journal tested (Table 4).

Discussion

Pursuing accurate references in a journal article may seem simple or trivial, yet citations in today’s journals contain a high rate of errors. These errors may impede

proper crediting for original research or substantiation of authors’ claims. Even worse than preventing propagation of relevant prior research, quotation errors of prior studies may misrepresent others’ research and lead readers to erroneous conclusions that affect patient care.

Considering the rapid rate of growth of the spine literature, proper identification of supporting literature and its accurate use is paramount. When examining citation errors in spine journals, it appears that the spine literature contains a higher percentage of errors than other specialty literature. However, on careful examination, the 85.9% overall error was inflated, because 82% of all these errors consisted of an omitted issue number. When examining citation instructions for the journals, it was often not specified that the issue number was required in the citation. In addition, given the missing issue number, the articles were all easily identified despite this error. As a result, the 30.9% error rate was more reflective of the citation error rate in these journals. This is consistent with many other specialties’ literature—such as emergency medicine, dentistry, pharmacy, orthopedics, general surgery, otolaryngology, dermatology, and anesthesia, which demonstrated error rates ranging from approximately 10% to 50%.^{4–6,8,10,13–16} Although all of these specialties should strive to standardize and enforce correct literature citation, most

TABLE 2. Number of articles with citation and quotation errors for each journal type

Journal Name	No. of Articles w/ Errors per Journal					Articles w/ no Error	No. of Articles Analyzed
	Citation			Quotation			
	Major	Minor	Minor, Disregarding Issue No.	Major	Minor		
<i>Spine J</i>	5 (8.3)	51 (85)	11 (18.3)	6 (10)	2 (3.3)	8 (13.3)	60
<i>Spine (Phila Pa 1976)</i>	5 (8.3)	54 (90)	11 (18.3)	4 (7)	9 (15)	2 (3.3)	60
<i>J Neurosurg Spine</i>	0 (0)	47 (78.3)	0 (0)	5 (8.3)	3 (5)	9 (15)	60
<i>Global Spine J</i>	0 (0)	33 (82.5)	4 (10)	5 (12)	7 (17.5)	4 (10)	40
Total	10 (4.5)	185 (84.1)	26 (11.8)	20 (9.1)	21 (9.5)	23 (10.4)	220

Numbers in parentheses designate percentage of articles.

TABLE 3. Number of citation and quotation errors stratified by type and journal

Error	Spine J	Spine (Phila Pa 1976)	J Neurosurg Spine	Global Spine J	All Journals
Major citation errors					
Volume no.	2	0	0	0	2
Supplement no.	2	3	0	0	5
Journal name	1	1	0	0	2
Year of publication	0	0	0	0	0
Inaccurate pagination not overlapping correct pages	2	0	0	0	2
Total major citation errors	7	4	0	0	11
Minor citation errors					
Title	1	2	0	1	4
Authors' names	8	7	0	2	17
Issue no.	47	53	47	31	178
Inaccurate pagination overlapping correct pages	2	3	0	2	7
Total minor citation errors	58	65	47	36	206
Total minor citation errors, not considering issue no.	11	12	0	5	28
Quotation errors					
Major quotation error	6	4	5	5	20
Minor quotation error	2	9	3	7	21
Total quotation errors	8	13	8	12	41

Numbers vary from those in Table 2 because that table reports the number of articles with citation errors, whereas Table 3 reports the total number of errors (i.e., if an article had 2 errors in the same article it is counted as 1 in Table 2, but the number of errors is counted as 2 in Table 3). Also, as described in *Methods*, the quotation errors count only the more severe error found, so for quotation errors there will not be an article with more than one error; only the most severe error found is counted, given the fact that the reference could be checked more than one time if the reference was cited multiple times in the manuscript being analyzed.

errors in this study were minor, and all articles were easily searched and located in online databases.

Given that the cited articles were still discoverable, the more relevant error prevalent in spine literature is quotation error. By unintentionally misquoting an article, the meaning of the research is altered and may misinform readers. Once again, this study's error rate was similar to that of other specialties.^{4–6,8,10,13–16} With literature error rates of approximately 7% to 38% in quoting sources, a significant number of statements may misconstrue the meaning of the cited literature, perpetuating erroneous interpretations of data that may be cited in future publications.⁵

Although citation errors were significantly associated with the journal in which the articles were published, there was no significant association with any previously stated

risk factors for errors in citation,¹⁷ such as the number of authors, non-English-speaking country of origin, year of publication, or length of bibliography.

The most evident impact of citation errors identified in this study is that the credit given to others' cited original research could have been compromised, given the fact that even minor citation errors could lead to a loss of the citation in an author citation index or a decrease in the H-index calculated for an author. Nevertheless, the impact of the quotation errors is even more concerning because it may alter the perceived meaning of the research and perpetuate erroneous interpretations that can affect patient care.

Finally, whereas we congratulate *J Neurosurg Spine* for achieving no citation errors and minimal quotation errors, performing well on both fronts, we advocate that all spine

TABLE 4. Statistical evaluation of potential risk factors that could impact reference accuracy

Marker	Citation Error			Quotation Error		
	χ^2	df	p Value	χ^2	df	p Value
No. of authors (≤ 4 or > 4)	1.84	1	0.175	0.120	1	0.729
Official language of first author's country of origin (English vs non-English)	0.215	1	0.643	0.230	1	0.632
Year of publication (≥ 2014 or < 2014)	0.270	1	0.603	2.825	1	0.093
Length of bibliography (1–15, 16–30, 31–45, > 45 references)	0.399	3	0.941	2.640	3	0.451
Journal	9.006	3	0.029	5.995	3	0.112
Citation error				1.223	1	0.269

journals work toward meticulous and rigorous evaluation of both citation and quotation of the literature. As the literature for spine surgery grows, citations and quotations will constitute the foundation needed to clearly communicate the prior evidence on which future research will be built.

Conclusions

Medical manuscripts are the mainstay to highlight and propagate medical advances in treatment. In order to advance medical treatment and patient care, detailed documentation and attention to detail are necessary. This review of reference accuracy in spine journals illustrates that improved accuracy in references and quoting of references is required.

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The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Harrop. Statistical analysis: Montenegro, Hines, Partyka. Administrative/technical/material support: Harrop, Montenegro, Hines. Study supervision: Harrop.

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