

Critical analysis of the use of statistical tests in Brazilian publications related to digestive tract surgery

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SUMMARY

Objective: To evaluate the evolution of scientific papers published on digestive tract surgery in Brazilian journals in 20 years and examine whether the level of evidence in the studies has improved, as well as the incorporation of statistical procedures and their proper application. **Methods:** We selected all original articles related to digestive tract surgery published in the years of 1987 and 2007 in 4 leading Brazilian surgical journals. Studies were divided according to the level of evidence (I: prospective, controlled and randomized, II: prospective without control or randomization and III: retrospective) and compared them to assess whether there was an improvement in the level of evidence between these two years surveyed. We also assessed whether there was increased use of analytical statistics and correct application of statistical procedures. **Results:** Comparing the articles published in 1987 with those of 2007, we observed no improvement with respect to the level of evidence, with more than half of the articles published being case series and retrospective studies (56.14%). There has been a significant increase in the use of analytical statistics (70.4% in 2007 vs. 40% in 1987) in the 20 years, however 16.7% of the studies published in 2007 did not correctly apply or adequately describe the statistical analyses used. **Conclusion:** In this study, we observed no improvement in the level of evidence presented in publications on digestive tract surgery in the last 20 years. There was an increased use of statistical analysis, but there is a need to correctly apply statistical procedures.

Keywords: Statistical analysis; gastrointestinal tract; scientific and technical publications; statistical methods and procedures.

RESUMO

Análise crítica do uso de testes estatísticos em publicações brasileiras relacionadas à cirurgia do aparelho digestivo

Objetivo: Avaliar a evolução dos trabalhos publicados sobre cirurgia do aparelho digestivo em revistas brasileiras nos últimos 20 anos, observando se houve melhora no nível de evidência destes trabalhos além da incorporação de procedimentos estatísticos e a sua correta aplicação. **Métodos:** Selecionamos todos os artigos originais relacionados à cirurgia do aparelho digestivo publicados nos anos de 1987 e 2007 em quatro revistas cirúrgicas nacionais de renome. Os estudos foram divididos de acordo com o nível de evidência (I: prospectivo, randomizado e controlado, II: prospectivo sem controle ou randomização e III: retrospectivo) e comparados para avaliar se houve melhora do nível de evidência entre os dois anos avaliados. Também observamos se ocorreu aumento no uso de estatística analítica e a correta aplicação dos procedimentos estatísticos. **Resultados:** Comparando os artigos publicados em 1987 com os de 2007, não observamos melhora no nível de evidência, com mais de metade dos artigos publicados tratando de séries de casos e estudos retrospectivos (56,14%). Houve um aumento significativo na utilização de estatística analítica (70,4% em 2007 vs. 40% em 1987) nos últimos 20 anos, mas 16,7% dos estudos publicados em 2007 não aplicavam corretamente ou descreviam adequadamente a análise estatística utilizada. **Conclusão:** Neste estudo observamos que não houve melhora no nível de evidência das publicações brasileiras relacionadas à cirurgia do aparelho digestivo nos últimos 20 anos. Houve aumento do uso de estatística analítica, porém existe a necessidade de se observar a correta aplicação dos procedimentos estatísticos.

Unitermos: Análise estatística; métodos e procedimentos estatísticos; trato gastrointestinal; publicações científicas e técnicas.

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INTRODUCTION

The number of studies on surgery with extensive statistical or epidemiologic evidence in medical literature is small.¹⁻⁷ The vast majority of studies describe non-randomized and non-controlled designs, or are based on retrospectively collected data. It is possible that this was due to the difficulty in performing randomized controlled studies in surgically treated pathologies, in contrast to the ease and low cost of case series. However, scientific publications have progressively increased the use of statistical procedures to support clinical inferences and more complex statistical tests are increasingly being used in studies published on surgery.¹

With increased use of advanced methodology, there is a risk of new bias, to which surgeons should pay attention as they read scientific articles. The inadequacy of methodological strategies may lead to erroneous results.

In literature, there are many articles that assess the evolution and correct use of statistical procedures in publications; however, there are few articles evaluating the surgical literature and none that evaluate Brazilian surgical publications.¹⁻⁵ In this study, our objective was to identify the current status of the use of analytical statistics in studies of digestive tract surgery in Brazilian journals and to assess whether there has been an increase in the use of statistical procedures in the last 20 years.

OBJECTIVES

The objective of this study was to identify how statistical procedures were incorporated in studies published on digestive tract surgery in Brazilian journals by analyzing the frequency of their use and correct application. This study also aimed to assess the level of evidence of these publications and to observe developments in the use of statistical procedures in the recent 20 year period cited.

METHODS

For this study, we selected all articles related to digestive tract surgery published during 2007 in the following journals: *Revista do Colégio Brasileiro de Cirurgiões* (Journal of the Brazilian College of Surgeons, RCBC), *Acta Cirúrgica Brasileira* (Acta of Brazilian Surgery), *Arquivos de Gastroenterologia* (Gastroenterology Archives, AG) and *Revista Brasileira de Colo-Proctologia* (Brazilian Colo-Proctology Journal, RBCP). In the Brazilian journals RCBC, AG and RBCP, articles published in 1987 were also included. These journals were selected because they publish studies on digestive tract surgery and are considered reputable publications in the country. Three of them are listed in PubMed (QUALIS B3- CAPES Medicine III) and one is listed in SicELO (QUALIS B4- CAPES Medicine III).

Only original articles with a description of their methods and results were included in this study. Articles identified as a literature review, editorial, letter to the editor, technical notes or a case report were excluded.

All studies on diseases of the gastrointestinal tract amenable to surgical treatment as well as diagnostic methods used in these pathologies (endoscopy, ultrasonography, computed tomography and laboratory tests) were considered “related to digestive tract surgery.”

To assess the level of evidence, the studies were divided into three classes: Class **I**: prospective studies, randomized and controlled, Class **II**: non-randomized studies in which data were collected prospectively or retrospective analysis of data evaluated prospectively (e.g., observational studies, cohorts, studies of prevalence and case-control studies) and Class **III**: studies based on data collected retrospectively. All experimental work was regarded as evidence level I, while clinical cases were divided into classes according to the study design.

An article was considered experimental when performed on animals, human cells or with laboratory measurements. Clinical articles were defined as those written with patient data and results.

With respect to the statistical method used, we divided the studies into three categories: **No statistics**, for studies that did not use any type of data analysis; **Descriptive statistics**, for those in which the statistical procedure was restricted to tabular representation of data, descriptive statistics and simple statistical calculations such as averages, percentages, medians and standard deviation; and **Analytical statistics**, for studies that used statistical procedures that involved inference regarding relations of existence, order or dependency based on probability theories.

We also evaluated the frequency of statistical methods used in the studies published in 1987 and 2007. All statistical tests cited in the studies, including those listed in captions and footnotes were counted. Each statistical procedure was counted only once per study no matter how many times it was applied. In the 2007 publications, we also verified whether these procedures were appropriate or not for analyzing the data in the study. For this evaluation, all descriptions of the methods and tables and charts of the articles published in 2007 were reviewed by an experienced epidemiologist. Some studies presented incomplete descriptions of statistical procedures, making it impossible to understand how they were applied and we chose to separate these into a third group not assessed for lack of data.

For each study, we also analyzed whether data obtained were used as the basis for a reported conclusion. Those studies that cited the data in the discussion or conclusion were considered appropriate.

STATISTICAL ANALYSIS

Statistical analysis was performed using the Chi-square test. When this was not applicable, we used the Fisher's exact test. A p-value below 0.05 was considered significant.

RESULTS

In this study, we included 30 articles published in 1987 and 91 published in 2007 that were related to digestive tract surgery. We found 20 articles published in 2007 in *Acta Cirúrgica Brasileira* that were not included in the comparisons between the two years because we did not evaluate the articles of this journal in 1987. Among the articles published in 1987 in *Revista do Colégio Brasileiro de Cirurgiões*, *Arquivos de Gastroenterologia* and *Revista Brasileira de Colo-Proctologia*, 3.33% were experimental and 96.67% were clinical studies. There was an increase in the number of experimental studies in 2007, accounting for 19.7% of the published articles (Table 1A).

In the analysis of the level of evidence, experimental studies were not included. Only clinical studies were used for this assessment and among articles published in 1987, we categorized 3.45% in Class I, 41.38% in Class II and 55.17% in Class III. In 2007 these figures did not change substantially and we found 1.75% to be Class I, 42.11% Class II and 56.14% Class III (Table 1B).

Of the 30 studies evaluated on digestive tract surgery published in 1987, less than half (40%) performed analytical statistics. In these studies, the most common statistical procedures were the t-test and the Mann-Whitney test. The Chi-square and Fisher's exact tests were also used in some studies. All studies published in 1987 with analytical statistics used only one test. Of the 12 studies that presented analytical statistics, one did not name the test used, citing only the p-value and reporting the statistical significance without describing procedures applied.

Among studies published in 2007, there was an increase in the number of studies using analytical statistics. In the 71 studies evaluated, 70.42% used analytical statistical procedures (Table 1C). The most commonly used

procedures, in order of frequency, were the Student's t-test, Chi-square test, Fisher's exact test, Mann-Whitney and ANOVA. An increase in the number of tests per study was also observed, with a test/study ratio of 1.68. Of the studies that reported having used analytical statistics and provided p-values, three of them did not identify the test used.

There was some difficulty in the evaluation of the appropriate application of statistical tests because most studies had incomplete descriptions of the methods used, applied the wrong terminology or did not detail how statistical analyses were applied nor did they show where each test was applied. In some studies, the statistical description reported tests that were not applied in any part of the study. Other studies only described the proportions of positive events and failed to show tables, so adequate information was not available. Several studies, despite using correct procedures did not use the most appropriate test for the type of variable under study.

A study that did not use the most appropriate test but nevertheless reached a correct result was not considered inappropriate. Only studies containing gross errors that brought forth unreliable results were considered inappropriate. We reviewed the correct application of statistical methods in papers published in 2007 in *Revista do Colégio Brasileiro de Cirurgiões*, *Acta Cirúrgica Brasileira*, *Arquivos de Gastroenterologia* and *Revista Brasileira de Colo-Proctologia* and found no statistical difference between them ($p = 0.187$). Twelve percent of the studies with analytical statistics contained serious errors in the application of statistical tests and were considered inappropriate (Table 2). Problems encountered in these studies included disregard for the dependence of the variables, errors in study design and choice of inadequate testing. Of the 91 studies analyzed, 4.39% could not be evaluated because descriptions of the methodology and statistical analysis were too sim-

Table 1 – Comparison of articles published in 1987 and 2007

A. Type of study			
	1987	2007	p Value
Experimental N. (%)	1 (3.33)	14 (19.71)	
Clinical N. (%)	29 (96.67)	57 (80.29)	0.036*
Total	0	0	
B. Level of evidence - not including experimental studies			
	1987	2007	p Value
Class I N. (%)	1 (3.45)	1 (1.75)	
Class II N. (%)	12 (41.38)	24 (42.11)	1*
Class III N. (%)	16 (55.17)	32 (56.14)	
Total	0	0	
C. Use of statistical analysis			
	1987	2007	p Value
Yes N. (%)	12 (40)	50 (70.42)	
No N. (%)	18 (60)	21 (29.58)	0.004**
Total	0	0	

*Fischer's exact test; **Chi-square test

Table 2 – Appropriate application of statistical tests

2007	Yes	No	Not assessed**	Total	p Value
RCBC N. (%)	30 (90.90)	3 (9.09)	0	33	0.187*
AG N. (%)	15 (78.94)	4 (21.05)	0	19	
RBC N. (%)	14 (73.68)	3 (15.78)	2 (10.52)	19	
ACB N. (%)	17 (85.00)	1 (5.00)	2 (10.00)	20	
Total N. (%)	76 (83.51)	11 (12.08)	4 (4.39)	91	

*Fischer's exact test for comparisons between journals; **not assessed for lack of data in the article

plified to understand how they were applied. Other studies reported statistical significance and p-values but did not disclose the test used.

With respect to use of data in the conclusion, to our amazement, 4.39% of the articles did not use data obtained as the basis for discussion or conclusion of the study (Table 3). These articles based their conclusions and discussions on literature reviews without any analysis or comparison with the data obtained in the study.

DISCUSSION

This study was designed to assess the current status of publications in digestive tract surgery in Brazil. Therefore only studies related to this specialty were included. However, as observed in the literature, this study also probably reflects the pattern of publications in other surgical specialties.

The vast majority of available literature on surgery consists of case series and retrospective studies, followed by non-randomized studies. Case series have the advantage of being inexpensive, quick and easy to conduct. The nature of this surgical specialty makes it difficult to accumulate a number of cases suitable for randomized controlled trial. Although specialized clinics do evaluate and treat many patients with similar conditions over a one-year period, most surgeons need a decade to achieve an appropriate number of similar cases.

Of course, retrospective studies do have value. They play an important role in generating hypotheses for future research, produce detailed reports about unknown diseases and encourage future studies. However, case series and retrospective studies are the weakest evidence to assess effectiveness of treatment or establish causal relationship.

As most surgical studies are based on case reports, much of the surgical literature leaves room for doubt concerning conclusions.

In this study we observed that, among clinical studies on digestive track surgery published in Brazilian journals in 2007, 56.14% were retrospective, 42.11% were prospective non-randomized or controlled and only 1.75% were prospective randomized and controlled. Comparing these studies with those published in 1987, we found no change in this pattern over the last 20 years (55.17% in Class III; 41.38% in Class II; and 3.45% in Class I). These values were not different from those found in surgical literature worldwide. In 2006, Chang *et al.*² selected surgical articles from the journals *Archives of Surgery*, *Surgery* and *Annals of Surgery* and categorized 7.9% in Class I, 33.7% in Class II and 58.4% in Class III. Also in 2006, Manterola³ performed a study that evaluated a randomly selected sample of articles published in all journals in English listed in the ISI Journal Citation Report using the keyword "surgery." A total of 653 studies were evaluated. Of these, 71.9% were case series, 15.2% cohort studies and 12.4% randomized controlled studies.

Upon assessing articles based on the type of study, we realized that there was an increase in the number of experimental studies. Only 3.3% in 1987 were experimental studies while this percentage increased to 19.7% in 2007. Along with the number of experimental articles, use of analytical statistics in the studies also grew. In 1987, less than half of the studies (40%) used advanced statistical procedures. In 2007, the majority of studies (70.42%) used analytical statistics. The most commonly used statistical tests were Student's t-test, Chi-square test, Fisher's exact test, Mann-Whitney and ANOVA.

When examining the number of 2007 Brazilian articles that used analytical statistics, we perceived no difference between what we found and what has been described in literature. Wang and Zhang⁴ published a study in 1998 that evaluated the statistical methods in five major Chinese publications and found that 60% of the papers pub-

Table 3 – Use of data in conclusion

2007	Yes	No	Total	p Value
RCBC N. (%)	33 (100.00)	0	33	0.186*
AG N. (%)	18 (94.73)	1 (5.26)	19	
RBC N. (%)	17 (89.47)	2 (10.52)	19	
ACB N. (%)	19 (95.00)	1 (5.00)	20	
Total N. (%)	87 (95.6)	4 (4.39)	91	

*Fischer's exact test for comparisons between journals

lished used analytical statistics. In 2009, Robinson *et al*¹ published a study evaluating articles on surgery published in the *Annals of Surgery*, *British Journal of Surgery*, *The Surgeon* and the *Annals of Royal College of Surgeons of England* and found that 76.4% used statistical analyses.

Despite increased use of statistical procedures, we cannot disregard the importance of their correct application. In this study, we discovered that most studies presented wrong terminology, incomplete description of methods and disclosure of positive events without publishing tables. These studies hampered reader assessment and, in some cases, failed to provide information on statistical tests used. We found that 12.08% of the studies had serious errors in the use of statistical tests and were considered inadequate, whereas 4.39% could not be assessed due to abbreviated descriptions of the methods or omission of the statistical tests used.

In 2006, Kurichi and Sonnad⁵, evaluating articles published in *Annals of Surgery*, *Archives of Surgery*, *Journal of the American College of Surgeons*, *Journal of Surgical Research and Surgery*, stated that 27% of articles had problems in the use of analytical statistics.

This study showed that there were no changes in the level of evidence in Brazilian articles published on digestive tract surgery after 20 years. Most published studies were still retrospective studies. Use of analytical statistics increased during this period, but frequently application was still incorrect.

The complexity of statistical calculations and variety of tests available increasingly require assistance of statisticians and epidemiologists. These specialists are more familiar with the relevant statistical procedures and can better define the analysis strategies to avoid misunderstandings. In such collaborations, they undertake the process of inference with deductive procedures so that physicians may focus on inductive procedures collating knowledge of the surgical disciplines.

CONCLUSION

This study demonstrated that the quality of articles published in the area of digestive tract surgery is not satisfactory. Most articles were retrospective studies and there was no improvement in the level of evidence in the publications during these 20 years. There was an increase in the number of articles using analytical statistics, but correct description and implementation of these procedures requires attention.

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