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Citation classics in periodontology: a controlled study

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Abstract

Aim: The aims of this study were to identify the most cited articles in *Periodontology* published from January 1990 to March 2005; and to analyse the differences between citation Classics and less cited articles.

Material and Methods: The search was carried out in four international periodontal journals: *Journal of Periodontology*, *Journal of Clinical Periodontology*, *International Journal of Periodontics and Restorative Dentistry* and *Journal of Periodontal Research*. The Classics, that are articles cited at least 100 times, were identified using the Science Citation Index database. From every issue of the journals that contained a Classic, another article was randomly selected and used as a Control.

Results: Fifty-five Classics and 55 Controls were identified. Classic articles were longer, used more images, had more authors, and contained more self-references than Controls.

Moreover Classics had on the average a bigger sample size, often dealt with etiopathogenesis and prognosis, but were rarely controlled or randomized studies.

Conclusions: Classic articles play an instructive role, but are often non-Controlled studies.

Key words: citation Classics; controlled study; methodological quality; number of authors; number of pages; periodontology; sample size; Science Citation Index; self-references; St. Matthew's effect

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Progress in science is mostly built upon the findings of research reported in scientific articles. Subsequent studies refer to and build upon the articles published through the years by various authors sharing the same interests.

Generally an author uses a reference to inform the reader about someone else's statements or results (Liu 1993, White & Wang 1997). Nevertheless references may also be used with the intent to persuade the reader about a particular argumentation the author is sustaining and to strengthen his point of view (Gilbert 1977, Brooks 1985, Dawson 1989, Dumont 1989).

Conflict of interest and source of funding statement

The authors declare that they have no conflict of interest.
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Eugene Garfield is the main author of a database named Science Citation Index (SCI) published by Thomson Scientific in the *Science Citation Index Expanded*® format, available online through the *Web of Science*®. This database indexes articles published in accredited scientific journals and their references. In this way, it is possible to verify which previous studies an author is referring to and who cited a certain article (Garfield 1955).

The large majority of scientific papers are seldom cited in subsequent literature and only few articles in a given discipline achieve a high number of citations (Seglen 1992). Articles that obtain more than 100 citations are considered ''citation Classics'' because they are thought to have a strong impact on research in that field (Dubin et al. 1993, Fenton et al. 2002, Aronson 2004).

Characteristics of an article, which may be responsible for it to become a Classic may be grouped as follows: (a) paratextual variables, (b) methodological variables, (c) statistical variables and (d) clinical variables. Paratextual variables refer to the features of an article other than the actual text: journal of publication, title, authors, number of authors, year of publication, illustrations, references, etc.

Methodological variables (study material, typology of the study, sample methodology, etc.) and statistical variables (significance, number of patients, etc.), may arouse interest in the publication. Some clinical variables may also influence the number of citations obtained and they include follow-up length, introduction of an original technique, perceived clinical relevance and the objective of the study.

The features of ''citation Classics'' have been investigated in the fields of general medicine, ophthalmology, dermatology, anaesthesiology, otolaryngology,

surgery, pain, critical care and traumatology (Garfield 1987, Albert 1988, Dubin et al. 1993, Hall 1998, Fenton et al. 2002, Paladugu et al. 2002, Terajima & Aneman 2003, Baltussen & Kindler 2004a, b, Ollerton & Sugrue 2005).

To date there has been no analysis of ''Classics'' published in *Periodontology*.

The aims of this study were (1) to identify the most cited articles in *Periodontology* published since 1990 by means of searching the SCI; and (2) to analyse the differences in paratextual, methodological, statistical and clinical variables between Classics and less cited articles randomly selected from the same issues of the same journals.

Material and Methods

Article selection

In April 2005 in the field *Dentistry, Oral Surgery & Medicine* of the database of the Institute for Scientific Information available on the web (www.isiknowledge.com) five journals had in the title the term Periodontal/Periodontology: *Journal of Periodontology*, *Journal of Clinical Periodontology*, *International Journal of Periodontics and Restorative Dentistry* and *Journal of Periodontal Research and Periodontology 2000*. *Periodontology 2000* was excluded from the present research as the articles published on this journal are all essentially narrative reviews. One operator conducted a search through the four international periodontal journals remaining: *Journal of Periodontology*, *Journal of Clinical Periodontology*, *International Journal of Periodontics and Restorative Dentistry* and *Journal of Periodontal Research*. The issues of the journals published from January 1990 to April 2005 were chosen as the objective of the research was to investigate citation modalities of recent articles. Among the articles published those cited at least 100 times were selected using the SCI database and were defined as ''Classics''.

From each issue of the journal that contained a Classic, another article was randomly selected to be used as a control. The selection was performed using a list of computer-generated random numbers. The exact number of citations for the Control was also assessed using the SCI at April 2005.

The operator recorded the following variables:

- ''Position'': the respective position in order of publication in the journal.
- ''Number of citations'': the number of time the article was mentioned in other articles published in accredited scientific journals up to April 2005.
- ''Number of self-citations'': the number of times one or more of the authors mentioned the article in subsequent publications up to April 2005.
- ''Number of citations from non-dental journals'': the number of mentions in articles published in journals not included in the *Dentistry, Oral Surgery & Medicine* subject category of the ISI web site.

Evaluation of Articles

All the Classic and Control articles were read by two researchers independently and ''blindly'' on the number of citations received.

The two operators recorded on separate forms 24 variables for each article as shown in Table 1. If the two operators were not in agreement they met to find a concordance. If the meeting failed a third operator, evaluating their positions, decided on the score to assign to the variable.

Among the analysed variables some of the features were:

(a) Paratextual variables

- ''Funding'' was classified as: ''Commercial'' when financial aid from a corporation (or similar) was specified in the acknowledgments; ''Non-Commercial'' when it came from a public source (government or similar agency) or non-profit organizations; and ''Not Clear'' whenever the sponsor was not named in the acknowledgments section.
- ''Individual patient data'' indicated the presence of fully reported data for every case, which would allow repeatability of the statistical analysis.
- ''Nationality of the first author'' referred to where the first author carried out the research: USA *versus* rest of the world.
- ''Number of self-references'' was the number of articles in the reference section to which at least one of the authors had contributed.

Table 1. Recorded paratextual variables and inter-examiner reliability tests

Variables	κ, ρ
Paratextual variables	
Funding	0.86
Individual patient data	0.82
Nationality of the first author	0.94
Number of authors	1.00
Number of diagrams	0.94
Number of images	0.99
Number of pages	1.00
Number of references	1.00
Number of self-references	0.97
Number of tables	0.95
Setting	0.74
Structured abstract	0.89
Title with methodological implications	0.88
Year of publication	1.00
Methodological variables	
Controlled study	0.78
Study material	0.78
Multicentric studies	0.64
Sampling methodology	0.34
Topic	0.78
Statistical variables	
Main variable studied	0.74
Significance	0.83
Sample size	1.00
Clinical variables	
Follow-up	0.77
New technique	0.74
Perceived clinical relevance	0.13

κ: kappa statistics: used for binomial variables.
ρ: intraclass correlation coefficient: used for metric variables.

- ''Setting'' indicated whether the research activity was conducted in a University or private setting.
- ''Structured abstract'' indicated an abstract that was clearly divided into sections: introduction, materials and methods, results and conclusions.
- ''Title with methodological implications'' indicated whether or not the study type, e.g. controlled, randomized, case series, etc. was clearly expressed in the title.

(b) Methodological variables

- ''Controlled study'' indicated the presence in the study of a control group. Systematic reviews were considered ''controlled studies'' while narrative reviews were considered ''non-controlled studies''.
- The variable ''study material'' comprised: patients, animals and in vitro. The study was considered ''in vitro'' if it regarded experiments on cells, but if the study was histological on human tissue the material of the study was considered ''patients''

as the research variables subject of the study referred to specific patients.
- ''Multicenter studies'' were conducted in two or more centres, otherwise the study was considered ''single-center''.
- The modalities of the variable ''sampling methodology'' consisted of ''random'', ''consecutive'' or ''not specified''.
- The variable ''topic'' included: therapy, diagnosis, prognosis, etiopathogenesis, epidemiology and anatomy.

(c) Statistical variables

- ''Main variable studied'' was the main variable considered in the statistical analysis. If more than one variable was studied, the most important one was considered as the main variable. The measurements of recession (Rec), probing depth (PD) and clinical attachment level (CAL) were grouped to form one variable. The same thing was done with the radiological variables.
- ''Significance'' indicated whether or not the main variable analysed exceeded the threshold of statistical significance ($\alpha = 0.05$).
- The ''sample size'' was the number of statistical units included in the study groups and present until the end of follow-up.

(d) Clinical variables

- ''Follow-up'' indicated the length of the study in years. This variable was considered 0 for cross-sectional studies and not specified for literature reviews.
- ''New technique'' was employed when the article introduced a new technique or theory not previously described in the literature.
- ''Perceived clinical relevance'' was assessed as follows: two other operators (expert periodontists) read and assigned a score to the abstracts of all the selected articles. They were not informed about the aim of the study, the authors, or the journal in which the articles were published. Each practitioner was instructed to assign a score from 0–10, where ''0'' indicated that reading the abstract of the study had no influence on his clinical practice, while ''10'' indicated that the results could be applied to clinical practice immediately.

Statistical Analysis

The Classic and Control articles were matched on the basis of the issue in which they were published.

Inter-examiner reliability analyses were performed for all variables of the 110 articles evaluated by the first two operators. For the metric variables intraclass correlation coefficient was used (ρ) while for the binomial variables the κ statistics were used. The two operators were considered reliable for the variable analysed if the ρ or κ index was higher than 0.70 and only variables associated with κ or $\rho \geqslant 0.70$ were selected for further analysis.

Inter-examiner reliability analysis was also performed for the two practitioners who assessed the perceived clinical relevance; in this case too a threshold of 0.70 indicated good reliability.

For the variables expressed on a metric scale, the calculated descriptive statistics were expressed as mean $\pm$ standard deviation when strong asymmetries were absent, and with median and inter-quartile interval in case of strong asymmetries.

For the continuous variables the analysis of variance (ANOVA) was performed using blocks formed by the matched pairs of articles (Classic and relative Control).

In cases of strongly asymmetric variables the Wilcoxon test for matched data was performed.

The Cochran–Mantel–Haenszel test was used for nominal variables.

If the value of one variable was missing in one of the paired articles the pair was discarded from the statistical analysis for that variable. Taking the ''structured abstract'' variable as an example, if one of the two matched articles did not have an abstract, the pair was not included in the statistical analysis.

Results

In the present study, 55 Classic articles and 55 matched Control articles were found and are listed in Table 2 in decreasing order of number of citations.

As to the breakdown among the four journals, 56% of the Classics (31 articles) came from the *Journal of Periodontology* (*JP*), 25% (14) from the *Journal of Clinical Periodontology* (*JCP*), 13% (7) from the *Journal of Periodontal Research*, and 5% (3) from the *International Journal of Periodontics and Restorative Dentistry*.

Some features of the citations received by Classic and Control articles are listed in Table 3.

The median of the number of citations received by Classic articles was 125 citations, eight articles received more than 200 citations and three articles received more than 300 citations. The most cited article was by Socransky & Haffajee (1992) with 346 citations.

The median of the number of citations received by Control articles was 14. The most cited article among the Controls received 57 citations. The number of self-citations found in the SCI was greater for the Classics but the ratio ''self-citations/total citations'' was greater for Control articles. The number of citations obtained from non-dental journals was greater for the Classics but the ratio ''citations from non-dental journals/total citations'' was not different between Classics and Controls.

The position in the issue was 5.56 ± 3.25 for Classics and 5.69 ± 3.75 for Controls ($p = 0.8423$).

Reliability

The results for the inter-operator reliability for paratextual, methodological, statistical and clinical variables are given in Table 1. Only the ''sampling methodology'', ''multicentric'' and ''perceived clinical relevance'' variables were lower than the pre-selected threshold of 0.70 and therefore were eliminated from further analysis.

Descriptive and inferential statistics

The results of the paratextual, methodological, statistical and clinical variables are presented in Tables 4, 5, 6 and 7, respectively.

Some relevant features are:

Paratextual variables

Classics had more authors than the Controls and the difference was significant.

Table 2. Classic and matched Control articles identified

Number of citations	Classic articles	Number of citations	Control articles
346	Socransky & Haffajee (1992)	31	Listgarten (1992)
307	Grossi et al. (1994)	39	White et al. (1994)
306	Kornman et al. (1997)	33	Salvi et al. (1997)
287	Page (1991)	24	Lamster et al. (1991)
253	Jaffin & Barman (1991)	40	Klausen (1991)
230	Socransky et al. (1998)	23	Flemmig et al. (1998)
219	Grossi et al. (1995)	17	Grbic et al. (1995)
205	Masada et al. (1990)	42	Childs & Gibbons (1990)
194	Haber et al. (1993)	7	Morrow et al. (1993)
193	Birkedal-Hansen (1993b)	49	Mangan et al. (1993)
189	Birkedal-Hansen (1993a)	1	Rowland (1993)
181	Lynch et al. (1991)	30	Stabholz et al. (1991)
167	Moore et al. (1991)	9	Donner & Eliasziw (1991)
166	Stashenko et al. (1991a)	11	Hanes et al. (1991)
161	Becker & Becker (1990)	53	Cortellini et al. (1990)
157	Offenbacher et al. (1993)	4	Swieter et al. (1993)
155	Buser et al. (1993)	3	Bergamaschi et al. (1993)
155	Slots & Rams (1990)	11	Nikoskelainen (1990)
154	Genco (1992)	10	Fine (1992)
151	Stashenko et al. (1991b)	24	Kingman et al. (1991)
142	Beck et al. (1990)	57	Osborn et al. (1990)
133	Cortellini et al. (1993b)	50	Kaldahl et al. (1993)
132	Boyne et al. (1997)	5	Tinti et al. (1997)
132	Sigurdsson et al. (1995)	1	Holt et al. (1995)
131	Caffesse et al. (1990)	27	Fox et al. (1990)
131	MacFarlane et al. (1992)	8	Turesky et al. (1992)
130	Bergstrom & Preber (1994)	57	Hart et al. (1994)
125	Tonetti et al. (1995)	6	Gustafsson et al. (1995)
124	Axelsson et al. (1991)	13	Linden & Newman (1991)
122	Matsuda et al. (1992)	50	Ali et al. (1992)
121	Emrich et al. (1991)	22	Novaes et al. (1991)
118	Anderegg et al. (1991)	14	Wikesjo et al. (1991)
116	Renvert et al. (1990)	10	Jorkjend & Skoglund (1990)
115	Seymour et al. (1993)	6	Meyle (1993)
112	Ah et al. (1994)	54	Van der Weijden et al. (1994)
111	Haraszthy et al. (2000)	8	Boltchi et al. (2000)
111	Lang et al. (1990)	18	Gillett et al. (1990)
110	McCulloch & Bordin (1991)	42	Ishihara et al. (1991)
110	Rodenburg et al. (1990)	5	Cobb et al. (1990)
109	Haffajee et al. (1997)	14	Macgregor et al. (1997)
108	Preber & Bergstrom (1990)	4	Carnevale et al. (1990)
108	Socransky & Haffajee (1991)	8	Taichman et al. (1991)
106	Becker et al. (1992)	9	Rossmann et al. (1992)
105	Pini-Prato et al. (1992)	16	Vogel et al. (1992)
105	Quirynen & Bollen (1995)	14	Renvert & Birkhed (1995)
105	Selvig et al. (1992)	7	Nagy et al. (1992)
105	Van Winkelhoff et al. (1992)	26	Fedi & Killoy (1992)
104	Cortellini et al. (1993a)	19	Nieminen et al. (1993)
104	Goodson et al. (1991)	53	Mombelli et al. (1991)
103	Miyasaki (1991)	4	Yamalik et al. (1991)
103	Tonetti et al. (1993)	43	Machtei et al. (1993)
102	Wikesjo et al. (1992)	36	Hart et al. (1992)
100	Cortellini et al. (1993c)	12	Akalin et al. (1993)
100	Cortellini et al. (1996)	11	Dodson et al. (1996)
100	Seibert & Nyman (1990)	11	Nery et al. (1990)

Selected pairs of articles in decreasing order from the most cited Classic to the least cited.

The difference in number of images between Classics and Controls was at the threshold of statistical significance.

The number of pages, the number of references and the ratio ''self-references/total references'' were significantly higher for the Classic articles.

Methodological variables

Classics were less often controlled studies than the Controls (Table 4). Randomized studies accounted for seven of the Classic (13%) and nine of the Control articles (16%). Fourteen Classic articles (25%) and 10 Controls (18%) were narrative reviews. No systematic reviews were found.

Frequent topics were ''*etiopathogenesis*'' and ''*diagnosis*'' for the Classics and Controls, respectively. The topic ''*therapy*'' was treated in the same number of Classic and Control articles (36%). The difference between Classics and Controls for the topics dealt with was significant ($p = 0.0020$).

Statistical variables

The analysis of the main variable covered 41 pairs of articles; 14 pairs were excluded because at least one of the two studies did not include any statistical analysis.

Sample size analysis covered for 37 pairs of articles: 18 pairs were excluded because there was no discussion of this variable. The median was calculated instead of the average because of the presence of a statistical unit with a very high value (41,142 patients) (Macgregor et al. 1997). The Classics showed a greater sample size than Controls and more frequently investigated PD, CAL or Rec.

Clinical variables

As regards the ''follow-up'' variable only 37 pairs of articles presented this data and could be evaluated.

No differences were found between Classics and Controls for the duration of follow-up or for the introduction of new techniques.

Discussion

In this controlled study, the most cited articles published in the four periodontal journals selected (Classics) since 1990 were identified and compared with less-cited articles randomly selected from the same issues of the journals.

Four of the oldest and most widely read international journals were chosen as the sources of periodontal Classics. A Classic was matched to a Control, which came from the same issue of the same journal in order to allow a comparable time of exposure for both articles to be noted and cited. The pairing also made it possible to eliminate the influence of the

Table 3. Citations in Classic and Control articles

	Number of pairs	Classics	Controls	*p*-value
		mean	mean	
Number of citations	55	148.53 ± 58.96	21.81 ± 17.20	–
Self-citation (SCI)	55	9.34 ± 6.83	2.58 ± 3.10	<0.0001
Self-citation/total citation	55	0.07 ± 0.06	0.14 ± 0.17	0.0144
Citation from non dental journal	55	28.09 ± 28.14	4.71 ± 7.09	<0.0001
Citation from non dental journal/total citation	55	0.17 ± 0.15	0.22 ± 0.26	0.2068

Table 4. Paratextual variables in the Classic and Control studies

Paratextual Variable	Number of pairs	Classics	Controls	*p*-value
Metric variables		mean	mean	
Number of authors	55	4.29 ± 2.54	3.45 ± 1.54	0.0361
Number of diagrams	55	2.95 ± 5.19	1.73 ± 2.53	0.0869
Number of images	55	4.93 ± 9.47	2.91 ± 4.65	0.0629
Number of pages	55	9.20 ± 3.56	6.80 ± 2.93	0.0004
Number of references	55	52.84 ± 44.48	36.53 ± 28.25	0.0405
Number of self-references	55	8.60 ± 6.36	4.00 ± 4.51	0.0001
Self-references/references	55	0.20 ± 0.12	0.12 ± 0.13	0.0028
Number of tables	55	3.56 ± 2.79	2.91 ± 2.50	0.2088
Nominal variables		percentage	percentage	
Author (USA)	55	64	49	0.1167
Funding (Commercial sponsor)	55	20	13	0.1025
Individual patient Data	55	15	13	0.7630
Setting (University)	55	85	87	0.7815
Structured abstract	50	2	2	1.0000
Title with methodological implications	55	18	16	0.8084

For nominal variables the *p*-value was calculated with the Cochran–Mantel–Haenszel test. For metric variables the *p*-value was calculated with the ANOVA test using blocks formed by the matched pairs of articles (Classic and relative Control).

Table 5. Methodological variables in the Classic and Control studies

Methodological variable	Number of pairs	Classics	Controls	*p*-value
Nominal variables		percentage	percentage	
Controlled studies	55	49	69	0.0164
Study material (patients)	55	78	65	0.1266
Topic: anatomy		5	16	
Topic: diagnosis		0	20	
Topic: epidemiology		11	6	
Topic: etiopathogenesis	55	31	16	0.0020
Topic: prognosis		15	2	
Topic: therapy		36	36	
Topic: other		2	4	

The *p*-value was calculated with the Cochran–Mantel–Haenszel test.

impact factor and other differences such as the layout or format of different journals or of the same journal over the years. Some studies (Callaham et al. 2002, Aksnes 2003a) have noted that the impact factor of a journal plays an important role in determining citation frequency.

The articles were not matched by the type of study published because one of the aims of this research was to determine whether there was any difference among Classics and Controls in relation to study design.

This study indeed showed that Classics distinguished themselves in a significant way from less cited articles. The Classics presented more and more often famous authors, were richer in images, were longer and contained more references, the sample size was bigger and more often dealt with variables commonly used in clinical practice like PD or CAL. In other fields, studies similar to the present one showed a general correlation between citation counts and number of pages and between citation counts and number of authors (Peters & Van Raan 1994, Aksnes 2003a, Perneger 2004). Aksnes affirmed that papers with many authors may increase the citation counts by an enhanced dissemination in the research communities through the personal communications of many authors (Aksnes 2003a). Moreover Yitzhaki affirmed that longer papers are supposedly more complex, more comprehensive and include more ideas (Yitzhaki 2002).

These results might lead to the conclusion that Classic articles are more convincing and serve a better educational purpose because they use every available tool to explain the results achieved and to support their theories. In fact many authors agree that a scientific article has the dual task of illustrating and persuading (Rangachiari 1994). Seglen states that citation rates are determined by so many technical factors that pure scientific quality may be a very minor influence (Seglen 1997).

Often Classics were narrative reviews, which made a survey of current knowledge of a determined subject. It is possible that authors of subsequent articles may prefer to cite these reviews instead of the source articles, which were reported in the review. In fact several studies reported that narrative reviews are overrepresented among highly cited papers (Glänzel & Czerwon 1992, MacRoberts & MacRoberts 1996, Aksnes 2003b). This study showed the same trend and among the most-cited articles found some were in fact non-systematic reviews (Page 1991, Socransky & Haffajee 1992). The reviews were generally written by scientists who are experts on the subject and, due to St. Matthew's effect, benefit from an enhancement of credit in the scientific community (Merton 1968). St. Matthew's effect refers to a passage from the Gospel according to St. Matthew:

Table 6. Statistical variables in the Classic and Control studies

Statistical variable	Number of pairs	Classics	Controls	*p*-value
Metric variables		median	median	
Sample size	37	39.5 [115]	24.5 [51.5]	0.0212
Nominal variables		percentage	percentage	
Main variable studied (PD, CAL, Rec)	41	49	17	0.0046
Significance	35	63	51	0.1586

For nominal variables the *p*-value was calculated with the Cochran–Mantel–Haenszel test. For metric variables the *p*-value was calculated with the Wilcoxon test. The interquartile distance is reported in the square parentheses.
PD, probing depth; CAL, clinical attachment level; Rec, recession.

Table 7. Clinical variables in the Classic and Control studies

Clinical variable	Number of pairs	Classics	Controls	*p*-value
Metric variables		mean	mean	
Follow-up (years)	37	1.13 ± 2.73	0.98 ± 2.43	0.8066
Nominal variables		percentage	percentage	
New technique	55	16	15	0.7815

For nominal variables the *p*-value was calculated with the Cochran–Mantel–Haenszel test. For metric variables the *p*-value was calculated with the ANOVA test using blocks formed by the matched pairs of articles (Classic and relative Control).

''For whosoever hath, to him shall be given, and he shall have more abundance; but whosoever hath not, from him shall be taken away even that he hath.'' (Matthew 13:12). In science, we may interpret this statement as meaning that scientists who are highly regarded by their colleagues from other research groups are more frequently cited than less known colleagues thus magnifying their reputation. Regarding the methodological quality of the articles analysed, randomized controlled studies are considered to be the gold standard of scientific research for results and reliability. The randomized design may always be used in protocols which compare therapies but the same is not always possible for research on etiopathogenesis or epidemiology. Considering that the present research evaluated studies that covered various topics from etiology, to diagnosis, to prognosis, to epidemiology and to therapy, it was not possible to evaluate the methodological quality based on randomization of the sample. As these studies could have presented a test and a control group, the evaluation of the methodological quality of the papers was based on the presence of a control group, and controlled studies were considered more reliable. In a study that regarded patient compliance lifestyle, Bruer noticed that ''there is no evidence that randomized trials are cited more frequently than studies that employ older experimental design'' (Bruer 1982). In fact, in this study, fewer randomized trials were found among Classic articles than among the Controls. Surprisingly, this study has shown that, from a methodological standpoint the Classics were more frequently non-controlled studies (non-systematic reviews, case reports, case series). More frequently Classics may have generated novel hypotheses or perspectives that may be tested in further clinical trials. However, highly influential papers, in terms of citation count, are not necessarily the most important papers in terms of clinical practice where we should indeed expect to see an overrepresentation of high quality RCTs.

In addition to its actual content, one of the features that may draw attention to an article may be its position in the journal with the idea that an article on the first pages of the issue may receive more attention than an article in another position. This hypothesis, however, was not confirmed in the present study.

Another consideration is the fact that Classics contained a high number of self-references and a higher self-references/references ratio. The number of self-references in a paper reflects the number of papers an author has already produced in a specific field; and the extent to which the author confines his interest to that field (Pichappan & Sarasvady 2002). Tagliacozzo stated that self-references serve the essential function of connecting the work reported in the citing paper to the author's previous work, thereby avoiding repetition of information available in that work. In addition, the self-citation often shows that the citing paper amplifies, modifies or corrects the results reported in previous writings (Tagliacozzo 1977).

As could be expected the number of self-citations was higher for Classics, however, the self-citations/citations ratio was higher for Controls. As a matter of fact, even a few self-citations for the Control articles could change this ratio as the Control articles received a low number of total citations (Aksnes 2003b).

Although therapy was the most common topic for Classic and Control articles, 31% of the Classics dealt with etiopathogenesis as opposed to just 16% of the Controls. This could be explained by the authors' habit of mentioning the etiopathogenesis of periodontal disease in the introduction of their articles, even if that is not their main topic. In fact, Voos and Dagaev found that on the average the source articles, when highly cited, seem to occur more in the introduction than anywhere else in the article (Voos & Dagaev 1976).

Our survey of the literature was limited to articles originally published in four selected *Clinical Periodontology* journals therefore some *Periodontology* citation Classics that were originally published in other medical journals or in implant dentistry literature were not recognized as such on our list in Table 2. The present study only considered papers published after 1990 in order to analyse more recent articles containing several new features that may have been of interest to other authors such as study design, a structured abstract, etc. Most of the Classics identified were published in the early 1990s reflecting the longer time they had to achieve more than 100 citations. Articles published more recently could with time accumulate

enough citations to become Classics. On the other hand our aim was to compare highly cited articles with less cited ones published at the same time so it is very unlikely that the Controls could reach theirs matched Classics with time. In fact many authors have shown that the early citation rate is a good predictor of the later citation rate (Glanzel 1997, Burrell 2003).

In conclusion, Classic articles showed several characteristics that enhanced their informative/instructive role. They were longer, they used more images, they had more authors who were most likely already well known, they contained more self-references, and they dealt with etiopathogenesis and prognosis more often.

From a methodological standpoint as Classics were more frequently non-controlled studies, they were prone to bias and may not be the most appropriate source of information when it comes to making clinical decisions.

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Clinical Relevance

Scientific rationale for the study: The aim of this study was to highlight the peculiar characteristics of articles that received more than one hundred citations published from 1990 to 2005 in four international periodontal journals.

Principal findings: Classic articles appear to be persuasive even if often, they are not controlled studies.

Practical implications: Classic studies are not necessarily of high methodological and clinical quality. Practitioners should not rely on Classics as such to guide their clinical practice.