




Dupuytren's Contracture: The Readability of Online Information

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Abstract

Dupuytren's contracture is a common hand pathology for which consultation and treatment are largely at the patient's discretion. The objective of this study was to evaluate the readability of current online patient information regarding Dupuytren's contracture. The largest public search engines (Google, Yahoo, and Bing) were queried using the search terms "Dupuytren's contracture," "Dupuytren's disease," "Viking's disease," and "bent finger." The first 30 unique websites by each search were analyzed and readability assessed using five established algorithms: Flesch Reading Ease, Gunning-Fog Index, Flesch-Kincaid Grade level, Coleman-Liau index, and Simple Measure of Gobbledygook grade level. Analysis of 73 websites demonstrated an average Flesch Reading Ease score of 48.6 ± 8.0 , which corresponds to college reading level. The readability of websites ranged from 10.5 to 13.3 reading grade level. No article was written at or below the recommended sixth grade reading level. Information on the internet on Dupuytren's contracture is written at higher than recommended reading grade level. There is a need for high-quality patient information on Dupuytren's contracture at appropriate reading grade levels for patients of various health literacy backgrounds. Hospitals, universities, and academic organizations focused on the development of readable online information should consider patients' input and preferences.

Keywords

Dupuytren's disease, Dupuytren's contracture, readability, reading grade level, health literacy

Introduction

The internet is becoming an increasingly ubiquitous source of health information. More than 56% of the world's population, and more than 80% of the developed world, has access to the internet (1,2). A sizable percentage of hand surgery patients research their conditions on the internet prior to their initial consultation, and the information available on the internet informs their self-assessment and diagnosis and frames subsequent discussions in the office (3–5). As such, it is important that patients of all health literacy levels have access to appropriately written health-related information needed to make informed decisions (6). Online materials must be written at an appropriate reading level to communicate health information to the target audience effectively. The American Medical Association, the National Institutes of Health, and the Centers for Disease Control and Prevention recommend that patient education materials be written at or below the fourth to sixth grade reading level (7,8); however, several sources have indicated that online education materials for common hand surgery conditions are written above the recommended reading level (9–12).

Dupuytren's disease is a common hand disorder. Its prevalence in the United States is estimated to be 7.3% of the general population (13). Dupuytren's disease involves the deposition of scar tissue in the palm of the hand, which may form cords over time and cause flexion contractures of the digits that can be functionally limiting. The rate of progression of Dupuytren's contracture is quite variable, and indications for treatment are largely based on subjective functional limitations; therefore, patients' understanding of disease pathophysiology, as well as the risks and benefits of treatment options, is

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important. The readability of current online information regarding Dupuytren's disease is not well-described.

The primary objective of this study was to evaluate the readability of online patient information regarding the Dupuytren's contracture. The secondary objective of this study was to determine whether the readability of this information differed by the medical complexity of the search term and category of the website.

Materials and Methods

This was an internet-based study without human subjects, and therefore, institutional review board approval was deferred. Internet websites pertaining to Dupuytren's disease were identified using Google, Bing, and Yahoo, the three most popular search engines at the time of this investigation (14). Search terms were identified using Google Trends. The most common search terms of varying levels of medical complexity were chosen to represent patients with varying levels of health literacy seeking online information regarding Dupuytren's contracture. The search terms used were "Dupuytren's contracture," "Dupuytren's disease," "Viking's disease," and "bent finger". The four search terms were entered in the three search engines on May 7, 2020, resulting in a total of 12 unique searches. Cookies, location, and user account information were disabled before each search to avoid any unintended bias in search results. The first 30 results from each of the 12 searches, a total of 360 websites including the sponsored ads, were screened. Nonfunctional websites, duplicate websites, websites unrelated to patient information regarding Dupuytren's contracture, and video websites were excluded from the analysis. The application of these exclusion criteria resulted in a final list of 73 unique websites for analysis. Resultant websites were further classified by website category. Categories included academic (affiliated with or published by a university, medical center, or health organization), private medical (not affiliated with an academic institution), commercial (sponsored ads), media, social networking, and miscellaneous (not included in the above categories). Websites were also classified according to search term. Our search terms ranged from lower complexity ("Viking's disease" and "bent finger") to higher complexity ("Dupuytren's contracture" and "Dupuytren's disease").

The articles were copied in plain-text format and analyzed using open-source software for calculation of readability scores (readabilityformulas.com). The readability of each website was assessed using five validated algorithms for readability: Flesch Reading Ease, Flesch-Kincaid grade level, Coleman-Liau index, Gunning-Fog index, and Simple Measure of Gobbledygook (SMOG) Grade Level (15-19). The readability algorithms take into account factors such as letters per word, syllables per word, words per sentence, and the ratio of complex words (Table 1). The Flesch Reading Ease is scored from 0 to 100, where higher scores entail greater readability. A Flesch Reading

Table 1. Readability Measurement Formulas.

Readability measure	Formula
Flesch reading ease	$206.835 - 1.015 \left(\frac{\text{words}}{\text{sentences}} \right) - 84.6 \left(\frac{\text{syllables}}{\text{words}} \right)$
Gunning-Fog index	$0.4 \left[\frac{\text{words}}{\text{sentences}} + 100 \frac{\text{complex words}}{\text{words}} \right]$
Flesch-Kincaid grade level	$0.39 \left(\frac{\text{words}}{\text{sentences}} \right) + 11.8 \left(\frac{\text{syllables}}{\text{words}} \right) - 15.59$
Coleman-Liau index	$0.0588 \left(\frac{\text{letters}}{100 \text{ words}} \right) - 0.296 \left(\frac{\text{sentences}}{100 \text{ words}} \right) - 15.8$
SMOG grade	$3.1291 + 1.0430 \sqrt{(\text{complex words}) \left(\frac{30}{\text{sentences}} \right)}$

Ease score of 90 to 100 is generally appropriate for elementary school students, a score of 60 to 70 for middle school to high school students, and a score of 0 to 30 for postgraduate students (20). The remaining four readability algorithms, the Flesch-Kincaid grade level, Coleman-Liau index, Gunning-Fog index, and SMOG grade level, produce scores that correspond directly to the academic reading grade level of the material. By these metrics, lower scores entail greater readability.

Descriptive statistics for readability were also calculated for all websites, histograms were created, and results were given as mean \pm standard deviation. Descriptive statistics for readability were calculated for websites grouped by category and search term. The analysis of variance (ANOVA) test was used for unpaired comparisons of parametric readability data among different website types and search terms. The Student's t-test was used for unpaired comparisons between the parametric readability of the groups. We employed the standard significance criterion of $\alpha < 0.05$ for all statistical tests. All statistical analysis was performed using the GraphPad Prism 8.2 software (San Diego, CA).

Results

Readability scores were calculated for 73 unique websites pertaining to Dupuytren's contractures. The average Flesch Reading Ease was 48.6, consistent with materials written at a college reading level (20). The average reading grade

Table 2. Readability of Online Information on Dupuytren's Contractures.

Readability measure	Score ^a
Flesch Reading Ease	48.6 \pm 8.0 (31.7-68.2)
Gunning-Fog index	13.3 \pm 1.8 (9.3-17.6)
Flesch-Kincaid grade level	10.9 \pm 1.4 (7.5-13.9)
Coleman-Liau index	11.9 \pm 1.6 (8.7-15.1)
SMOG grade	10.5 \pm 1.1 (7.6-13.1)

^aThe values are given as the mean \pm standard deviation, with the range in parentheses.

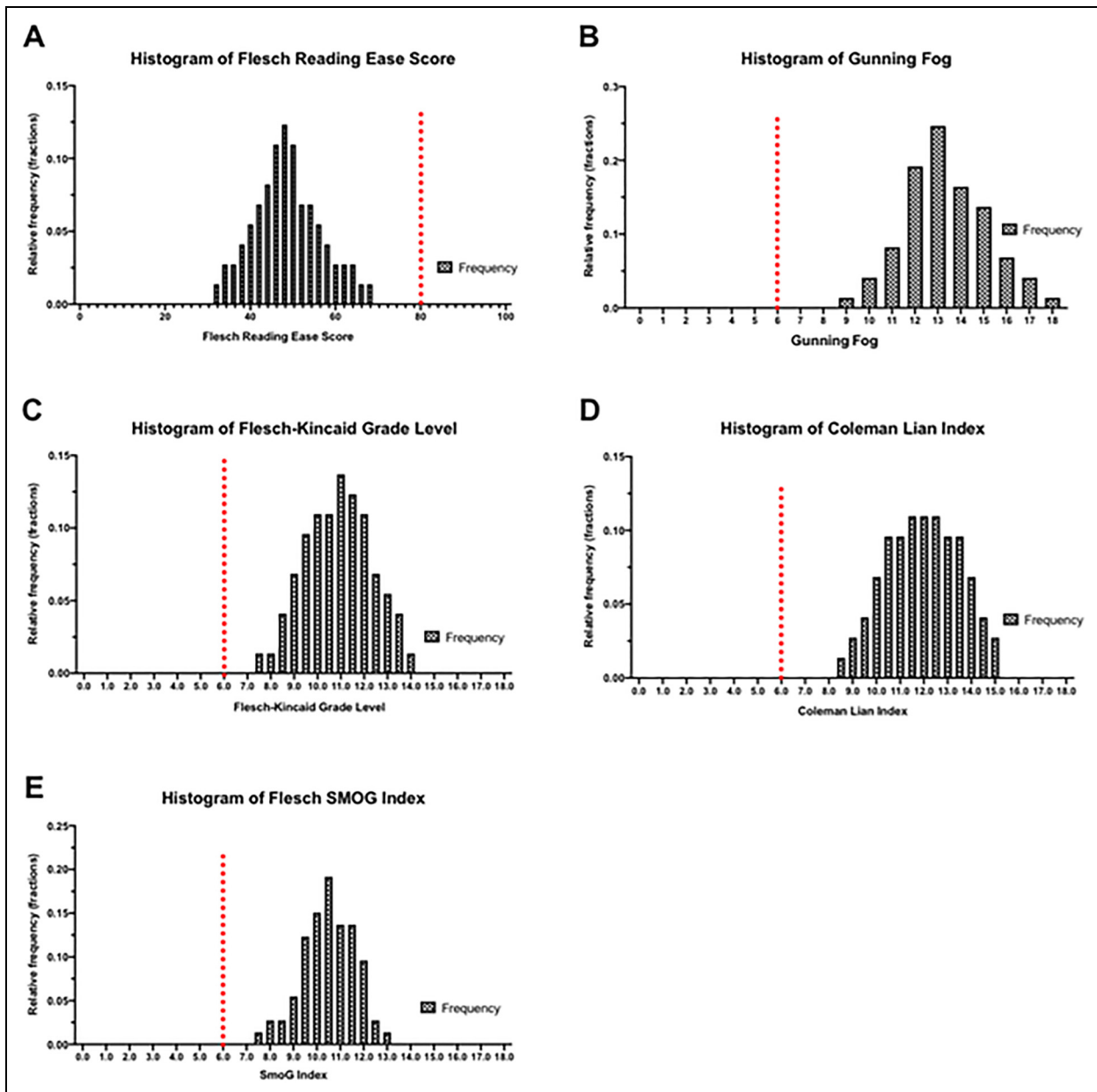


Figure 1. Histograms depicting the distribution of internet information on Dupuytren's contracture by readability score, as determined by Flesch Reading Ease score (A), Gunning–Fog index (B), Flesch–Kincaid grade level (C), Coleman–Liau index (D), and SMOG grade (E). The vertical dotted lines denote the recommended reading levels.

level calculated by the remaining four algorithms range from 10.5 to 13.3 (Table 2). The average reading grade level of online information on Dupuytren's contractures was four to seven grade levels higher than recommended, based on all five readability algorithms (Figure 1). None of the 73 online articles in this study were written at or below the sixth grade reading level. Using a tolerant measure of readability, the Flesch–Kincaid grade level, 1.4% of articles were written between sixth and eighth grade levels, 71.8% between eighth and twelfth grade levels, and 26.8% at or above the twelfth grade reading level (Table 3).

Of the 73 unique websites, 27 were academic, 24 were private medical, 9 were commercial, 6 were media, 4 were social networking, and 3 were miscellaneous. The ANOVA test demonstrated a significant difference in readability among the various website categories ($P < 0.001$). The Student's *t*-test showed that academic websites were written at a significantly higher reading grade level ($P = 0.01$), whereas media ($P = 0.002$), social networking ($P = 0.001$), and miscellaneous ($P = 0.001$) websites were written at a significantly lower reading grade level.

The ANOVA test demonstrated a significant difference in readability among the various search terms ($P = 0.02$). The

Table 3. Number of Online Articles Relative to Reading Grade Level.^a

Readability measure	≤6th grade	6th-8th grade	≥8th-12th grade	≥12th grade
Gunning–Fog index	0 (0%)	0 (0%)	18 (24.6%)	55 (75.3%)
Flesch–Kincaid grade level	0 (0%)	1 (1.4%)	52 (71.2%)	20 (27.4%)
Coleman–Liau index	0 (0%)	0 (0%)	39 (53.4%)	34 (46.6%)
SMOG grade	0 (0%)	2 (2.73%)	63 (86.3%)	8 (10.9%)

^aThe values are given as the number (%) of articles.

Student's t-test showed websites resulting from the search terms "Dupuytren's contracture" and "Dupuytren's disease" were of marginally higher reading grade level than "Viking's disease" and "bent finger" ($P=0.05$).

Discussion

Dupuytren's contracture is a common hand pathology with a broad age range of initial presentation and variable rates of disease progression. Indications for treatment are based largely on patient-perceived functional limitations. As patients increasingly turn to the internet as their first source of health information, there is a need for high-quality, accessible information for the general public. Given that the average reading grade level of the U.S. population is at the eighth grade level, multiple national agencies have recommended the readability of health information be provided at or below the sixth grade reading level (7,8,21). In this study of 73 unique online articles pertaining to Dupuytren's contractures, using five different validated readability algorithms, we found that none of the top 30 websites obtained for four different search terms on the three most used search engines returned any articles written at the recommended reading level.

The readability of online information on Dupuytren's contracture has been reported by Santos et al., who studied the 10 most popular websites queried from Google using the search term "Dupuytren's contracture surgery" on February 26, 2016 (22). At that time, the authors found an average Flesch Reading Ease of 46.4, Flesch–Kincaid grade level of 10.2, Gunning–Fog index of 13.1, Coleman–Liau index of 14.4, and SMOG grade level of 10.0 and concluded that online articles on this topic were written at higher than recommended reading level. In our study, we have studied a more substantial body of internet information on Dupuytren's contractures and found worse readability levels than previously published by all metrics except the Coleman–Liau index, indicating that no progress has been made in the years since Santos et al.

The plurality of search results were academic websites written by hospitals, universities, or organizations. These websites were found to not only provide information at a higher

than recommended reading level but also were written at a significantly higher reading level than other websites. Our findings suggest a role for hospitals, universities, and organizations to produce high-quality internet information pertaining to Dupuytren's contracture at lower reading grade levels in order to benefit patients of all health literacy backgrounds. For example, the following statement is written at a Flesch–Kincaid grade level of 13: "In Dupuytren's disease, fibroproliferative tissue is deposited in the palmar fascia of the hand. This deposition can form cords over time and cause digital flexion contractures. Fixed flexion contractures can be functionally limiting." The same information can be delivered using patient-oriented language at a Flesch–Kincaid grade level of 4: "In Dupuytren's disease, scar tissue builds up in the palm of the hand. The scar tissue can form cords over time. This can cause the fingers to bend towards the palm. Not being able to straighten the fingers can limit the use of the hand."

There are limitations to this study. First, while we have assessed readability through five validated and widely used readability algorithms, these algorithms are not exhaustive (22,23). Second, because we analyzed only the plain-text of online articles, we were unable to account for illustrations, animations, photographs, and videos, which may improve patients' understanding. Third, while we have presented the largest analysis of the readability of online information on Dupuytren's contracture to date, our sample size was limited. This precluded subgroup analyses for example, by each specific non-academic website category. Finally, it remains to be shown whether algorithmic measures of readability correlate with patients' perception of the utility of health information (24).

Readability of online health information is an important metric, but one part of an arsenal of tools for developers of online health education. Readability algorithms analyze plain text and do not weigh the effects of pictures, videos, or interactive modules, which can be useful supplements to end-user comprehension. Moreover, many algorithms weigh complex words or polysyllabic words negatively, but some complex words are inherently useful to the understanding of the medical condition. "Dupuytren's contracture" is a case in point. Finally, the readability of online information must be balanced against its quality, to ensure that patients have access not only to materials that are understandable but also accurate. An outcome of interest for developers of online health education is patients' perception of the utility of health information. Whether patient self-reported utility of health information correlates with algorithmic readability is still unclear (24). Future studies on the utility of online information on Dupuytren's contracture may incorporate patient end-user feedback in order to better develop the most appropriate and accessible health information.

Conclusions

Current online information available to patients pertaining to Dupuytren's contracture is written above the recommended reading grade level. In the last half decade, the trend in the

readability of online information on Dupuytren's contracture has shown no improvement. Hospitals, physician groups, universities, and professional societies have a responsibility to ensure that high-quality information is made available at appropriate reading levels in order to optimize accessibility in healthcare. The development of readable online health information on Dupuytren's contractures should take into account patients' inputs and preferences.

Ethical Approval

Ethical approval is not applicable for this article.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

There are no human subjects in this article, and informed consent is not applicable.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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