Irish Journal of Medical Science (1971 -)
https://doi.org/10.1007/s11845-022-03252-y

ORIGINAL ARTICLE

Quality assessment and comparison of two- and three-dimensional YouTube videos as additional educational tools for cataract surgery: "METAVERSE"

Hamidu Hamisi Gobeka[1] · Furkan Fatih Gülyeşil[2] · Zubeyir Yozgat[3] · Mehmet Cem Sabaner[4]

Received: 14 September 2022 / Accepted: 9 December 2022

Abstract

Background To compare the content and quality of 3D YouTube videos with 2Ds as additional educational tools for phacoemulsification surgery.

Methods This cross-sectional study included 2D and side-by-side 3D phacoemulsification videos found on YouTube by searching for "*phacoemulsification*," "*phaco*," and "*cataract*." Data was collected on video length (min), time since upload (days), number of views, likes, dislikes, cataract type, chop technique, and visualization system. Video popularity and interaction were calculated by video power index, interaction index, and viewing rate. Two senior ophthalmologists (SOs) and two ophthalmology residents (ORs) evaluated videos using the DISCERN, global quality score (GQS), and usefulness scoring systems. Inter-rater reliability was assessed using intra-class correlation coefficient (ICC).

Results A total of 457 videos were screened, with 85 in 2D and 85 in 3D deemed appropriate for analysis. 2D videos received significantly more views, likes, dislikes, days since upload, video power index, and viewing rate than 3Ds ($p < 0.001$). Video length and interaction index in 3D videos were significantly greater than in 2Ds ($p < 0.001$). All video scoring systems revealed that 3D videos outperformed 2Ds in ORs ($p < 0.05$). ICC confirmed good inter-rater reliability agreement even at the lowest value (SOs: 0.924, 95% CI, 0.910–0.937; ORs: 0.892, 95% CI, 0.878–0.908).

Conclusions 3D YouTube videos as additional educational tools could help not only SOs but also ORs fully comprehend the breadth and depth of ocular surgeries, particularly phacoemulsification, by improving depth perception. They can also be used to review previously learned procedures, observe new ones, and recall old ones.

Keywords 3D videos · Cataract · DISCERN · E-learning · Global quality score · Phacoemulsification · YouTube

Background

Neal Stephenson, a science-fiction writer, coined the term "*metaverse*" in 1992, defining it as "the concept of a completely immersive virtual environment in which individuals can socialize, play, and work." This is a virtual environment that combines augmented reality, virtual reality, block-chain, as well as social media values to imitate the real world [1]. The current study provides some insight into the "*metaverse*" in terms of social media, which is becoming increasingly important in the healthcare system. While social media tools share characteristics such as ease of use, interactivity, and an absence of peer review, each tool has its own information and objective [2].

In medical education, e-learning is becoming increasingly popular [3]. Despite initial doubts about whether e-learning "works" or "performs better" than face-to-face learning [4],

✉ Hamidu Hamisi Gobeka
hgobeka@gmail.com

Furkan Fatih Gülyeşil
furkangulyesil@gmail.com

Zubeyir Yozgat
zubeyiryozgat@gmail.com

Mehmet Cem Sabaner
drmcemsabaner@yahoo.com

1 Department of Ophthalmology, Afyonkarahisar Health Sciences University, Afyonkarahisar, Turkey

2 Siirt Training and Research Hospital, Siirt, Turkey

3 Department of Ophthalmology, Training and Research Hospital, Kastamonu University, Kastamonu, Turkey

4 Department of Ophthalmology, Kütahya Health Sciences University, Evliya Celebi Training and Research Hospital, Kütahya, Turkey

Published online: 19 December 2022

research has shown that e-learning produces results that are broadly comparable to face-to-face education [5]. Given the increased interest in additional educational and informational tools among not only senior ophthalmologists (SOs) but also ophthalmology residents (ORs), there is now a lot of curiosity about how medical practitioners gain knowledge online and evaluate the implications of their online training on patients.

The use of internet videos as an additional educational tool benefits both SOs and ORs significantly. This results in improved knowledge and less time spent learning various ophthalmic surgical procedures and skills [6, 7]. In this context, the presence of websites such as Phacopearls.com, EyeTube.com, and Eyesurgeryvideos.com, which already provide videos of various ocular surgeries, indicates an increasing prominence of educational ophthalmic video sharing [8]. Despite this, the eye has a complicated three-dimensional (3D) structure. Understanding ocular anatomy is difficult in the standard 2D settings used by the majority of websites. Moreover, it is impossible to abstractly conceptualize the ocular surgical procedure using 2D videos. As these videos lack a third dimension, critical surgical steps may be missed [9].

3D videos, on the other hand, incorporate exciting new technology that enables a better understanding of phacoemulsification surgery–related sensitive and accurate intraocular surgical manipulations. This technology has already proved to be beneficial during surgery [10, 11]. Moreover, digital 3D ocular models may be useful as an additional educational tool [12]. This has resulted in the use of YouTube videos as additional educational and information tools, garnering increased attention in the academic world. As far as social media is concerned, YouTube is the most popular video-sharing website globally, providing an open, easy, and integrated digital platform. This platform allows users to upload, share, watch, and comment on the respective videos. Furthermore, YouTube video–related basic and clinical science studies have been published for a variety of purposes, including assessing educational quality, accuracy, and so on [13–15]. To our knowledge, no study has been conducted to date on the content and quality of YouTube videos to compare the utility of 3D surgical procedure videos versus 2Ds as additional educational tools for cataract surgery, specifically phacoemulsification.

Thus, the current study intended to compare the content and quality of 3D YouTube videos with 2Ds as additional educational tools for phacoemulsification surgery in ophthalmology residence education.

Materials and methods

Design of the study

This cross-sectional and register-based study was approved by the Siirt University Clinical Research Ethics Committee, which followed the Helsinki Declaration principles (Ethics committee date and approval code: 2021/01.02).

A YouTube search was carried out on April 4, 2021 by entering the keywords "*phacoemulsification,*" "*phaco*," and "*cataract*" in the online search box at https://www.youtube.com, using the Mozilla Firefox (v86.0) browser. The search was done without requiring a user login and after clearing the browser's cache, cookies, and history. The standard search preferences were chosen as "sort videos by relevance."

Inclusion and exclusion criteria

The following criteria were used to determine inclusion: (a) standard complete phacoemulsification surgery, (b) English language content and relevance for phacoemulsification, and (c) side-by-side 3D videos. Videos with the following features were excluded: (a) voiceover or descriptive visual text in languages other than English, (b) animation videos, (c) videos without descriptive visual text or voiceover, (d) videos involving only one step of the surgery process, like IOL implantation or corneal incisions, (e) videos with the uploader's likes and dislikes disabled, (f) low-resolution (< 720p), and (g) 3D videos other than side-by-side type (Anaglyph Red/Cyan 3D and Top-and-Bottom 3D).

Data recording and calculation

The following parameters were recorded for 3D and 2D videos: video length in minutes, time since upload in days, number of views, likes and dislikes, upload source (physician, medical company, or others), chop technique (horizontal, vertical, stop-and-chop, flip and chop, pre-chop, divide and conquer, spin or carousel), and visualization system.

Video popularity was calculated using the video power index (VPI) [number of likes/(number of likes + dislikes) × 100]. Viewer interaction was calculated based on the interaction index (II) [(number of likes-number of dislikes)/total number of views × 100]. The viewing rate was calculated as the number of views divided by the number of days since the upload.

Video analyses

Videos were evaluated by active cataract surgery performers, which included two SOs and two ORs using the DISCERN, global quality score (GQS), and usefulness scoring systems. The evaluators were blinded to one another and to all other video aspects, including the number of likes, dislikes, and views.

The videos were viewed at the highest possible resolution from the source. 3D videos were watched binocularly on the same 3D 4 K TV (LG, 50LB670V, LG Electronics Inc., Korea), using side-by-side 3D option on, with polarized 3D glasses (LG, AG-F310, LG Electronics Inc., Korea) (Fig. 1). The 2D videos were also watched on this screen without 3D

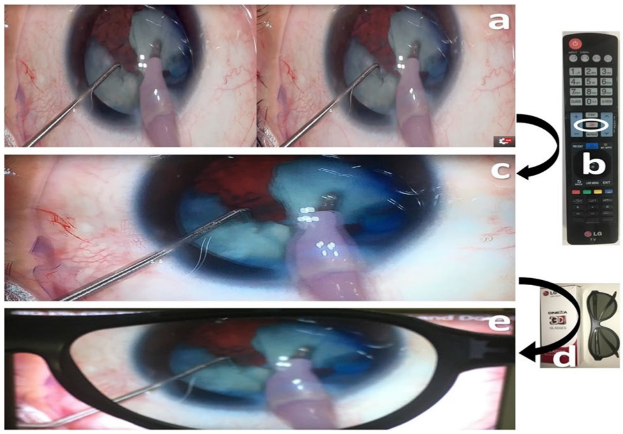

Fig. 1 An illustration of 3D video watching stages: **a** A side-by-side 3D phacoemulsification surgery video watching, **b** a 3D activation button on 3D TV remote (white circle), **c** watching 3D videos after 3D feature activated, **d** polarized glasses compatible with 3D TV screen, **e** watching 3D videos with polarized 3D glasses (watch the video here: https://www.youtube.com/watch?v=85X5eAKAJ8&t=352s)

glasses and with the 3D feature turned off. The videos were viewed while sitting upright and 2.5 m away from the screen.

Supplemental Digital Content 1 (Supplemental File 1) introduces the DISCERN, a 15-question scoring system in which each item is scored from 1 to 5 in order to assess the reliability and objectivity of medical information about a treatment. The DISCERN score ranges from 15 to 75 points and categorizes content as excellent (63–75 points), good (51–62 points), fair (39–50 points), poor (27–38 points), or very poor (15–26).

Supplemental Digital Content 2 (Supplemental File 2) introduces the global quality scoring system (GQS), which allows users to evaluate the video's content on a 5-point Likert scale. The GQS is a rating system that uses a scale of 1 to 5 to assess the video quality, streaming, and usability of information presented in online videos.

Videos' usefulness scores were determined using the following six criteria: definition, indication, contraindication, procedure involved, complication, and prognosis/survival. Each content area was scored 0–1 point, and a maximum of 6 points were acquired. A total of 0–2 points denoted poor video content with insufficient information about phacoemulsification, which was deemed useless. A total of 3–4 points denoted moderate video content that provided positive phacoemulsification information but poorly debated some information topics or surgical stages. A total of 5–6 points denoted high-quality video content that conveyed comprehensive and accurate surgical information.

Statistical analysis

Statistical analysis was performed using SPSS software, version 22.0 (IBM SPSS, Chicago, IL, USA). The data was evaluated using descriptive statistical methods (mean and standard deviation). The chi-square test was used to analyze categorical variables. The Shapiro–Wilk test was used to analyze the distribution of all parameters for normality. The Mann–Whitney U test was used to analyze the results of the scoring systems for 2D and 3D videos evaluated by SOs and ORs. The intra-class correlation coefficient (ICC) and its 95% confidence interval (CI) were used to determine inter-rater reliability. The ICC value > 0.8 indicated good repeatability, while a value > 0.9 indicated excellent measurement repeatability. Analyses were performed at the 95% CI, and p-values < 0.05 indicated a statistically significant difference.

Results

In the current study, 85 3D and 85 2D YouTube videos were analyzed (Fig. 2). Supplemental data file 3 contains a complete list of videos. There was no significant difference between the 3D and 2D videos sourced from 144 physicians and 26 medical companies ($p = 0.416$).

The videos contained 49 nuclear cataracts, 41 cortico-nuclear cataracts, 28 mature/hyper-mature cataracts, 17 soft cataracts, 17 cortical cataracts, 8 pediatric cataracts, and 7 traumatic cataracts, with no difference between the 3D and 2D videos ($p = 0.062$). The chop techniques featured in the videos included 56 horizontal, 27 flip and chop, 21 vertical, 17 stop and chop, 10 divide and conquer, 6 pre-chop, 5 spin carousel, and 2 laser

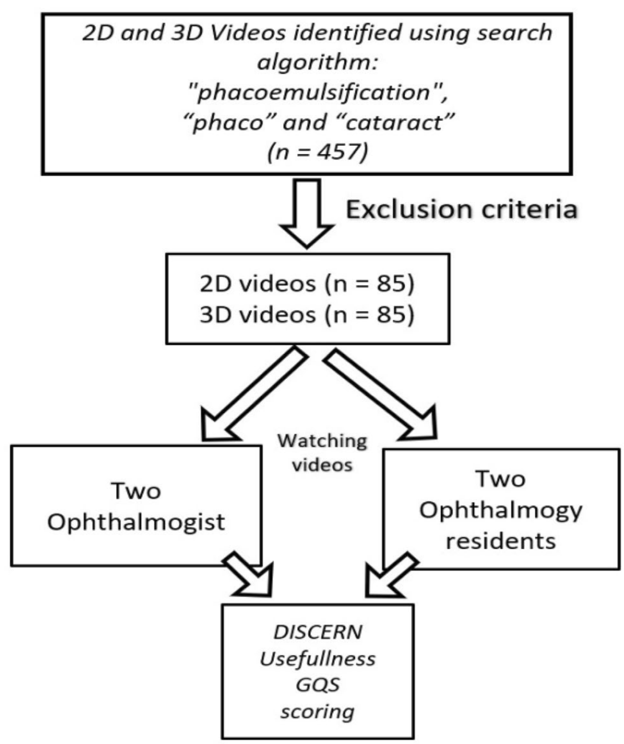

Fig. 2 The study design flowchart

Table 1 Descriptive statistical analysis of 2D and 3D YouTube videos about phacoemulsification surgery

Parameters	YouTube videos		p value*
	2D [median (min–max)]	3D [median (min–max)]	
Number of views	6031 (52–1,630,972)	228 (1–1627)	< 0.001
Number of likes	82 (0–10,000)	6 (0–61)	< 0.001
Number of dislikes	2 (0–923)	0 (0–2)	< 0.001
Time since upload (days)	790 (62–2456)	283 (15–2540)	< 0.001
Video length (minutes)	6.06 (2.28–66.56)	7.16 (3.51–19.06)	0.079
VPI	97.94 (53.85–100)	100 (80–100)	< 0.001
Interaction index	1.30 (0–3.89)	3.78 (0–100)	< 0.001
Viewing rate	9.83 (0.04–3179.28)	0.56 (0.01–15.21)	< 0.001

*Mann–Whitney U test results, *VPI* video power index, median (min–max) given within 95% confidence interval, $p < 0.05$ was considered statistically significantly different

assisted ($p < 0.001$). While horizontal chop (38/85) dominated the 3D videos, flip and chop (21/85), horizontal (19/85), vertical (17/85), and stop and chop (16/85) dominated the 2D videos.

The majority of the 3D visualization systems in the videos were Alcon NGENUITY 3D Visualization System (Alcon Laboratories, Fort Worth, TX), TrueVision 3D Visualization System (Leica, Wetzlar, Germany), and ARTEVO 800 system (Zeiss, Oberkochen, Germany). While the visualization system was clearly visible in the vast majority of 3D videos, it was not specified in the vast majority of the 2D videos. The majority of the 3D videos (75/85) were in 4 K resolution, whereas the majority of the 2D videos (73/85) were in 1080p resolution ($p < 0.001$).

The descriptive statistical analysis of the 2D and 3D YouTube videos about phacoemulsification surgery is presented in Table 1. The results of the scoring system for 2D and 3D videos are displayed in Table 2. A good inter-rater reliability agreement even at the lowest value was confirmed using the ICC (SO: 0.924, 95% CI, 0.910–0.937; OR: 0.892, 95% CI, 0.878–0.908).

Discussion

Indeed, medical students and practitioners are increasingly reliant on the internet for medical information, making the role of YouTube videos in surgeons' lifelong learning a critical aspect [16]. After all, the use of multimedia devices existed before the advent of social media. Watching actual resuscitation footage during a weekly conference was shown to increase the efficiency of actual resuscitations in 1988 [17]. YouTube videos for medical education could have evolved

Table 2 Results of the scoring systems for 2D and 3D videos by senior and resident ophthalmologists

Scoring systems	YouTube videos				p^* value
	2D [median (min–max)]		3D [median (min–max)]		
	SO group	OR group	SO group	OR group	
DISCERN	47.50 (15–74.50)	50 (15–75)	44 (15–73)	55.50 (15–75)	$p^1 = 0.150$ $p^2 < 0.001$ $p^3 = 0.378$ $p^4 = 0.001$
Usefulness score	4 (0–6)	3.5 (0–6)	3.5 (0.5–6)	4 (0–6)	$p^1 = 0.339$ $p^2 = 0.016$ $p^3 = 0.524$ $p^4 = 0.013$
GQS	3.5 (1–5)	3 (1–5)	4 (1–5)	4 (1–5)	$p^1 = 0.810$ $p^2 = 0.090$ $p^3 < 0.001$ $p^4 < 0.001$

*Mann–Whitney U test results (p^1 = 2D-SO versus 2D-OR, p^2 = 3D-SO versus 3D-OR, p^3 = 2D-SO versus 3D-SO, and p^4 = 2D-OR versus 3D-OR), median (min–max) given within 95% confidence interval. $p < 0.05$ was considered statistically significantly different, GQS: Global quality system

SO senior ophthalmologists, *OR* ophthalmology residents from the use of videotapes and DVDs in the past. These videos are more plentiful and more easily obtained, but they are also more difficult to monitor for quality [2].

The current study could be the first to compare the utility of 3D surgical procedure videos versus 2Ds as additional educational tools for cataract surgery, particularly phacoemulsification, by analyzing the content and quality of YouTube videos. There was no significant difference between the 3D and 2D videos obtained from physicians and medical companies. Nuclear (49) and cortico-nuclear (41) cataracts predominated, followed by mature/hypermature (28), soft (17), cortical (17), pediatric (8), and traumatic (7) cataracts, with no difference between the 3D and 2D videos. The vast majority of phaco chop techniques demonstrated in the videos were horizontal (56), followed by flip and chop (27), vertical (21), stop and chop (17), divide and conquer (10), pre-chop (6), spin carousel (5), and laser assisted (2).

The use of 3D technology in media has increased significantly over the last decade [18]. In the medical field, prior research demonstrated that 3D in the operating room has already been implemented in the fields of urologic and gastrointestinal laparoscopic surgery, with a positive impact in both settings, particularly for surgeons [11]. Alcon Laboratories, in collaboration with TrueVision 3D, has developed a 3D Visualization System based on recent advances in ophthalmic 3D technology. Instead of a traditional microscope, this system enables eye surgeons to operate on an HD 3D display. This new view also provides physicians with improved depth perception, which is not available at the moment on standard operating room displays [19]. The majority of the 3D visualization systems in the videos in the current study were also Alcon NGENUITY 3D Visualization System (Alcon Laboratories, Fort Worth, TX), as well as TrueVision 3D Visualization System (Leica, Wetzlar, Germany), and ARTEVO 800 system (Zeiss, Oberkochen, Germany). While the visualization system could be seen in the vast majority of the 3D videos, it was not specified in the vast majority of the 2D videos. The majority of the 3D videos (75/85) were found to support 4 K resolution, while the majority of the 2D videos (73/85) supported 1080p resolution ($p < 0.001$). These findings point to 3D video technology being useful as an additional educational tool for phacoemulsification procedures.

Despite the fact that 3D video technology aids in surgical accuracy and provides SOs and ORs with greater access to medical and surgical information, its impact as the additional education tool has not been thoroughly studied. Early research into the use of 3D technology in surgical ophthalmology education focused solely on the efficacy of 3D computer animations of surgical procedures as a supplement to traditional surgery videos [20, 21]. Another study concentrated exclusively on the prospective utility of digital 3D ocular models as an educational tool [12]. Despite this, there has been little research comparing the utility of YouTube 3D surgical procedure videos versus 2Ds as additional educational tools for phacoemulsification surgery, particularly for ORs or, at the very least, SOs. According to the current study, the 2D YouTube videos about phacoemulsification surgery received significantly more views, likes, dislikes, days since upload, VPI, and viewing rate than the 3D videos. The video length in minutes and interaction index in the 3D surgical videos, on the other hand, were both statistically significantly greater than in the 2Ds. It is possible that fewer people watched 3D videos because they require specialized equipment, such as imaging systems and polarized glasses, and thus have a significantly higher interaction index.

Using videos as a teaching modality in medical education has been shown to help students learn and retain information [22]. 3D video technology, which is especially useful in ophthalmology, enables a more ergonomic method of learning and performing surgery, with the ultimate goal of reducing surgeon fatigue and increasing surgical learning, achievement rate, and accuracy [11]. In the current study, all scoring systems for 2D and 3D surgical videos, including DISCERN, Usefulness score, and GQS, revealed that, when compared to the 2Ds, the 3D videos were associated with statistically significantly higher scores among ORs. The high resolution feature in the 3D videos could be an effective explanation for why these videos were scored significantly higher than the 2D videos. Applying 3D videos as the additional educational tool could actually enable not only SOs but also ORs to fully comprehend the breadth and depth of the ocular surgeries, in this case, phacoemulsification. Because of improved depth perception, 3D videos could be utilized to better appreciate ocular anatomy during more complex and delicate surgeries such as phacoemulsification.

As far as the study subject is concerned, 3D technology is pioneering the field as a novel and game-changing operational tool. A growing body of research has shown that 3D surgery is just as safe and effective as traditional microscopic surgery [23, 24]. Application of 3D animated surgery models [19, 21] seems to be a useful integral part to basic ocular education not only in the residency but also at the senior ophthalmology level, bridging the gap to a better understanding of 3D surgical video procedures such as phacoemulsification. Furthermore, there have only been a few reports on the anterior segment that have concentrated on the application of 3D systems in DMEK [25] and cataract surgery [26–28]. All of these reports, in essence, indicate that 3D video technology will be widely used in the near future, if not already present, not only for additional educational purposes in ORs but also for increased proficiency and advanced surgical knowledge and performance in SOs.

Despite the fact that the current study addresses some critical issues regarding the utility of 3D versus 2D YouTube videos for additional educational purposes, it is not without flaws, including (a) the inclusion of only English language YouTube videos, (b) the inclusion of only side-by-side 3D YouTube videos, and (c) the evaluation of only non-complicated cataract surgery. Besides, due to the extremely low image quality, videos with <720p resolutio were not evaluated because sufficient data analysis and interpretation could be compromised.

Despite these flaws, to the best of our knowledge, this is the first 3D-2D phacoemulsification YouTube video comparison study that revealed that using 3D videos as additional educational sources in ORs was more effective than using 2D videos. Also, in the current study, a greater number of videos were evaluated by two SOs and two ORs.

Conclusions

While YouTube phacoemulsification videos are not appropriate for beginners, they can be used to reinforce previously learned procedures, see new techniques, and recall old ones. In the current study, ORs found 3D phacoemulsification videos to be more useful and of higher quality than 2Ds. However, the 2D and 3D videos appeared to have the same benefit and quality in SOs. The surgery and operating room environment will become more perceptible in the future; thanks to imagery supported by Virtual Reality 360°/180° videos. Further research on high-quality 3D and virtual reality videos on the 3D learning effects, particularly in ophthalmology residency, is required in this relatively new technological field.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11845-022-03252-y.

Acknowledgements Special thanks to "Neto Rosatelli, MD," who uploaded and shared most of the side-by-side 3D phaco videos on YouTube. Also, special thanks to our friends of two blind ophthalmology specialists and two residents for video scoring support.

Author contribution Concept/design: FFG, MCS, and HHG; resources: ZY, FFG, and MCS; materials: MCS, FFG, and HHG; data collection: MCS, FFG, HHG, and ZY; analysis and/or interpretation: MCS, HHG, and FFG; literature search, HHG, MCS, and ZY; writing manuscript: HHG, MCS, and ZY; critical review: HHG and MCS.

Data Availability The manuscript contains all data. The datasets used and/or analyzed during the current study, however, are available upon reasonable request from the corresponding author.

Declarations

Ethics approval Institutional review board approval was obtained from the local ethics committee (Siirt University Ethics Committee, approval code: 2021/01.02).

Consent to participate Not applicable

Funding or financial support The authors declare that they have received no public or private financial support or involvement in the products, methods, or materials mentioned in this manuscript.

Conflict of interest The authors declare no competing interests.

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