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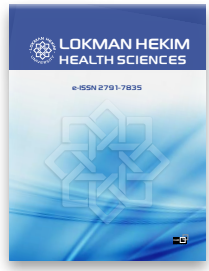


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ORIGINAL ARTICLE

# Measuring the Knowledge Level of Dental Students About Digital Dentistry and Evaluating the Access to Educational Resources: A Survey Study

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## Abstract

**Introduction:** This study aimed to determine whether the educational resources that benefit dental students are Internet-based sources or traditional lecture notes and books and to assess awareness and attitudes toward three-dimensional digital technologies among students.

**Methods:** Twenty questions of demographic information, knowledge levels of three-dimensional technology, and educational resources, such as traditional lecture notes and books or Internet-based sources, were asked of the students from the first class to the last at Ankara Yıldırım Beyazıt University Dental School. Data collected from this survey were analyzed using the SPSS 22 statistical program. Descriptive statistics, including frequency and percentage distributions, were used to evaluate the data. Besides, the relationship between the variables was examined using the chi-square ($\chi^2$) test and a significance level of $p < 0.05$ was considered.

**Results:** A total of 309 students were enrolled in the study. In terms of using knowledge sources among students, 84.8% benefited from lecture notes, 55.3% from YouTube videos, and 54.4% from other Internet sources. The most popular digital technologies known to students were three-dimensional printers (71.8%) and computer-aided design and manufacturing (66.7%).

**Discussion and Conclusion:** Although traditional lecture notes and books are still used for educational resources, the use of Internet resources is considerably higher. The increasing use of social media and the knowledge level of three-dimensional technology among students may require a shift from traditional to digital technology methods.

**Keywords:** Dentistry; Digital technology; Education; Knowledge resource

Any sort of feedback collected from faculty members or students is crucial for developing and improving educational processes in higher education institutions. The feedback received from student surveys about their learning experiences and teaching and learning methods is valuable in terms of performance and development.[1,2]

Dental education includes both theoretical and practical education.[2,3] In dental education, the accessibility of the faculty, the knowledge and behavior of the educator, and their reflection on the student are effective criteria.[2] In addition to books and lecture notes, the presentation of information on digital media has recently been frequently

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used.[4] Recently, in the field of dentistry, changes in learning techniques, technological teaching methods, and access to computerized resources have become more visible with the younger generations' interest in digital environments.[5] Simultaneously, the advent of social media, mobile devices, personal computers, clinical technologies, and visual technologies has changed educational courses. These technological resources allow students to access information, work remotely, and easily simulate educational environments.[6] YouTube is one of the media platforms most frequently used for this purpose.[5,7] Numerous videos with uploaded educational content have paved the way for students to use as resources for practical lessons. However, such Internet-based learning resources are debatable for videos that cannot be controlled and whose accuracy is questionable.[7] With these developments, the use of computer-based education has increased.[8,9] Moreover, three-dimensional (3D) learning modules on the Internet have widened students' perceptual perspectives.[9] A survey conducted by Pratheebha and Jayaraman[8] evaluated the satisfaction of 100 students with computer-mediated education and found that 92% of the students were satisfied with computer-mediated online learning, while 8% of them encountered some difficulties.

The use of 3D systems and virtual reality (VR) has increased recently. In dentistry, good perceptual and visual skills, as well as the perception of the size, distance, and position of objects, make them more comprehensible through 3D systems.[9,10] In addition, simulation-based teaching has a crucial place in education and training. More memorable, motivating, and association-based education using active learning methods is important for students to learn efficiently.[6,7]

Innovations such as computer-aided design and computer-aided manufacturing (CAD/CAM) and 3D printing and design have been frequently used in dental education. 3D printing has been successfully used to produce anatomical models that simulate clinical scenarios for dental education.[6,11,12] Such digital approaches have been supported by several studies and are used in digital analysis. In particular, identifying deficiencies that cannot be detected through traditional assessment processes, repeating assessments without bias, and eliminating subjective assessments are effective in improving objective assessments. 3D technology can provide students with a clear and objective preparation guide that allows them to self-assess their work while reducing their dependence on instructor feedback and increasing their self-learning. In addition, students have the opportunity to work independently outside their designated laboratory time.[6,13]

This survey aimed to determine the ways in which students access information, either through lecture notes or books, in traditional systems or Internet-based access sources. Additionally, it aimed to evaluate students' awareness of digital technology and its contributions to the educational process. The null hypothesis of this study was that students still use traditional lecture notes rather than digital technology as educational resources.

## Materials and Methods

This survey study was conducted at Ankara Yıldırım Beyazıt University School of Dentistry in the spring semester of the 2024-2025 Academic Year. It was approved by the Ethics Committee of Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee, dated 14.06.2023, decision number 06-293 and research number 2023/293. All the participants provided informed consent for inclusion in this study. This study was conducted in accordance with the principles of the Declaration of Helsinki.

The survey was administered to all dental students (1$^{st}$, 2$^{nd}$, 3$^{rd}$, 4$^{th}$ and 5$^{th}$-year students) at a public university in the capital city of Türkiye.

Prior to the main data collection, we conducted a cognitive-debriefing pilot with 30 dental students to assess the clarity, comprehensibility, and face validity of the survey items. Minor wording revisions were made based on participant feedback and observations. The primary analysis employed chi-square ($\chi^2$) tests to assess associations between categorical variables. Based on the contingency tables generated from pilot responses, we estimated an anticipated effect size of w=0.20 (Cohen's w), corresponding to a small effect. This value, commonly used in survey-based comparisons, was thus both prespecified and empirically justified. Using G*Power v3.1.9.7 for a chi-square test of independence, assuming $\alpha$=0.05 and power (1–$\beta$)=0.90. The analysis, calibrated for multi-contingency tables with degrees of freedom ranging approximately from 4 to 8, indicated a required minimum total sample size of N ≈ 265. The final study sample of N=309 exceeded this threshold, ensuring sufficient power to detect small effects.

The main survey was subsequently administered via Computer-Aided Web Interviewing (CAWI). The questions were directed at the cell phones and e-mail addresses of all students, and 309 people answered the survey questions. Of those who answered the questions, 64.4% (n=199) were female and 35.6% (n=110) were male participants.

**Table 1.** Descriptive characteristics of the students (n=309)

| | Number | Percentage (%) |
|---|---|---|
| Age | | |
| 18 | 11 | 3.6 |
| 19 | 17 | 5.5 |
| 20 | 38 | 12.3 |
| 21 | 75 | 24.3 |
| 22 | 75 | 24.3 |
| 23+ | 93 | 30.1 |
| Gender | | |
| Female | 199 | 64.4 |
| Male | 110 | 35.6 |
| Internet access | | |
| Wi-Fi from my computer | 103 | 33.3 |
| Self phone | 200 | 64.7 |
| Computers from library, faculty | 6 | 1.9 |
| Scholarship | | |
| Yes | 151 | 48.9 |
| No | 158 | 51.1 |
| Place of residence | | |
| Family house | 93 | 30.1 |
| State dormitory | 86 | 27.8 |
| Special dormitory | 40 | 12.9 |
| Rental house (alone) | 32 | 10.4 |
| Rental house (with friends) | 52 | 16.8 |
| Other (Relative's house etc.) | 6 | 1.9 |
| Total | 309 | 100 |

The survey questions were divided into three parts: demographic information in the first part, methods of accessing course resources in the second part, and knowledge of 3D technology and its effects on learning in the third part. Twenty questions were posed to the students. With the data obtained by evaluating the answers to these questions, it was planned to predict whether it would be beneficial to include digital technology in student education, students' tendencies in this regard, and which of the traditional methods or Internet-based sources is more effective in accessing information resources.

### Statistical Analysis

The data obtained in this study were analyzed using SPSS 22 (IBM SPSS Statistics 22, New York, USA). Descriptive statistics, including frequency and percentage distributions, were used. Besides, the chi-square ($\chi^2$) test was used for association/dependence tests in categorical variables and a significance level of $p<0.05$ was considered.

## Results

Three hundred nine students answered the survey questions. Of those who answered the questions, 64.4% (n=199) were female and 35.6% (n=110) were male participants. The demographic variables of the students who participated in the survey are presented in Table 1. The age distribution of the students was categorized according to class as 1st year: 18-19, 2 nd year: 20, 3rd year: 21, 4th year: 22, or 5th year: 23-23+.

Regarding the distribution of the answers to the questions related to the methods of accessing educational materials, the most used educational resources in dentistry were the lecture notes of faculty members (84.8%, n=262), and the least used were books/journals (36.9%, n=114). YouTube videos (55.3%, n=171) and Internet resources (54.4%, n=168) were also highly preferred as educational resources. The results of the chi-square test are shown in Table 2. The data obtained regarding learning techniques showed that the most efficient learning technique was face-to-face interaction between lecturers and students (81.2%, n=251), and the weakest technique was online lessons (19.1%, n=59), as shown in Table 3. Students mostly used YouTube videos (91.9%; n=223) for learning. Face-to-face teaching (77.7%, n=240) was advantageous for practical lessons. Table 4 illustrates how social media resources were used for educational and learning purposes as part of the practical lessons.

**Table 2.** Educational resources benefit by students

| | Class | | | | | | | | | | | | Df | Chi-square ($\chi^2$) test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class 1 | | Class 2 | | Class 3 | | Class 4 | | Class 5 | | Total | | | Chi-square | p |
| | n | % | n | % | n | % | n | % | n | % | n | % | | | |
| YouTube videos | 15 | 53.6 | 21 | 55.3 | 41 | 54.7 | 41 | 54.7 | 53 | 57.0 | 171 | 55.3 | 4 | 0.16 | 0.997 |
| Book/journals | 13 | 46.4 | 12 | 31.6 | 26 | 34.7 | 24 | 32.0 | 39 | 41.9 | 114 | 36.9 | 4 | 3.50 | 0.478 |
| Internet resources | 16 | 57.1 | 17 | 44.7 | 44 | 58.7 | 36 | 48.0 | 55 | 59.1 | 168 | 54.4 | 4 | 4.14 | 0.387 |
| Lecture notes | 25 | 89.3 | 35 | 92.1 | 65 | 86.7 | 62 | 82.7 | 75 | 80.6 | 262 | 84.8 | 4 | 3.72 | 0.445 |

Chi-square ($\chi^2$) test was used. Df: Degrees of freedom.

**Table 3.** Efficient learning techniques

| | Class | | | | | | | | | | | | Df | Chi-square ($\chi^2$) test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class 1 | | Class 2 | | Class 3 | | Class 4 | | Class 5 | | Total | | | Chi-square | p |
| | n | % | n | % | n | % | n | % | n | % | n | % | | | |
| Online lectures | 10 | 35.7 | 8 | 21.1 | 14 | 59 | 19.1 | 14.7 | 16 | 17.2 | 59 | 19.1 | 4 | 6.27 | 0.179 |
| Face to face | 20 | 71.4 | 29 | 76.3 | 56 | 251 | 81.2 | 86.7 | 81 | 87.1 | 251 | 81.2 | 4 | 8.03 | 0.090 |
| Self-study | 18 | 64.3 | 16 | 42.1 | 40 | 153 | 49.5 | 50.7 | 41 | 44.1 | 153 | 49.5 | 4 | 4.85 | 0.303 |
| Reading books | 6 | 21.4 | 8 | 21.1 | 16 | 70 | 22.7 | 22.7 | 23 | 24.7 | 70 | 22.7 | 4 | 0.38 | 0.984 |
| Internet resources | 7 | 25.0 | 12 | 31.6 | 26 | 95 | 30.7 | 25.3 | 31 | 33.3 | 95 | 30.7 | 4 | 2.31 | 0.679 |

Chi-square ($\chi^2$) test was used. Df: Degrees of freedom.

**Table 4.** Social media resources and learning methods

| | Class | | | | | | | | | | | | Df | Chi-square ($\chi^2$) test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class 1 | | Class 2 | | Class 3 | | Class 4 | | Class 5 | | Total | | | Chi-square | p |
| | n | % | n | % | n | % | n | % | n | % | n | % | | | |
| Social medias for education | | | | | | | | | | | | | | | |
| Youtube | 22 | 78.6 | 24 | 63.2 | 57 | 76.0 | 49 | 65.3 | 71 | 76.3 | 223 | 72.2 | 4 | 5.2 | 0.267 |
| Instagram | 8 | 28.6 | 10 | 26.3 | 25 | 33.3 | 36 | 48.0 | 45 | 48.4 | 124 | 40.1 | 4 | 10.59 | **0.032** |
| Twitter | 2 | 7.1 | 1 | 2.6 | 6 | 8.0 | 5 | 6.7 | 9 | 9.7 | 23 | 7.4 | 4 | 2.05 | 0.726 |
| Methods for practical lessons | | | | | | | | | | | | | | | |
| Face to face | 20 | 71.4 | 34 | 89.5 | 56 | 74.7 | 63 | 84.0 | 67 | 72.0 | 240 | 77.7 | 4 | 7.5 | 0.112 |
| Demonstrative models | 12 | 42.9 | 13 | 34.2 | 34 | 45.3 | 40 | 53.3 | 51 | 54.8 | 150 | 48.5 | 4 | 5.96 | 0.202 |
| 3D images in computers | 7 | 25.0 | 10 | 26.3 | 17 | 22.7 | 26 | 34.7 | 44 | 47.3 | 104 | 33.7 | 4 | 13.74 | **0.008** |
| Watching videos | 11 | 39.3 | 9 | 23.7 | 26 | 34.7 | 34 | 45.3 | 42 | 45.2 | 122 | 39.5 | 4 | 7.02 | 0.134 |
| 3D images with VR | 12 | 21.4 | 16 | 42.1 | 22 | 29.3 | 30 | 40.0 | 28 | 30.1 | 108 | 35.0 | 4 | 4.46 | 0.346 |

Chi-square ($\chi^2$) test was used. Df: Degrees of freedom; 3D: Three-dimensional; VR: Virtual reality. P values less than 0.05 are indicated in bold.

**Table 5.** 3D technologies followed by students

| | Class | | | | | | | | | | | | Df | Chi-square ($\chi^2$) test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class 1 | | Class 2 | | Class 3 | | Class 4 | | Class 5 | | Total | | | Chi-square | p |
| | n | % | n | % | n | % | n | % | n | % | n | % | | | |
| 3D Printers | 23 | 82.1 | 30 | 78.9 | 54 | 72.0 | 54 | 72.0 | 61 | 65.6 | 222 | 71.8 | 4 | 4.12 | 0.378 |
| CAD/CAM | 10 | 35.7 | 12 | 31.6 | 46 | 61.3 | 55 | 73.3 | 83 | 89.2 | 206 | 66.7 | 4 | 56.9 | **0.000** |
| AI | 17 | 60.7 | 18 | 47.4 | 25 | 33.3 | 34 | 45.3 | 38 | 40.9 | 132 | 42.7 | 4 | 7.08 | 0.132 |
| VR | 15 | 53.6 | 19 | 50.0 | 27 | 36.0 | 33 | 44.0 | 35 | 37.6 | 129 | 41.7 | 4 | 4.49 | 0.343 |
| Design Programs and 3D modeling | 6 | 21.4 | 10 | 26.3 | 30 | 40.0 | 28 | 37.3 | 45 | 48.4 | 119 | 38.5 | 4 | 9.78 | 0.44 |

Chi-square ($\chi^2$) test was used. Df: Degrees of freedom; 3D: Three-dimensional; CAD/CAM: Computer aided design and manufacturing; VR: Virtual reality; AI: Artificial intelligence. P values less than 0.05 are indicated in bold.

In the third part of the survey, where the level of knowledge about digital dentistry and 3D technology was measured, and several questions evaluating the place of this technology in education were asked, it was determined that all students had knowledge about 3D technology. Additionally, it was determined that the knowledge level of "CAD/CAM (Computer-Aided Design and Manufacturing)" and design programs and modelling among 3D technology

types increased with age ($p<0.05$). The 3D technologies followed are listed in Table 5.

Of the participants, 69.6% (n=215) stated that there was a difference between the use of 3D technology and traditional methods in terms of their application in dentistry, whereas 30.1% (n=93) stated that they had no knowledge. The workflow speed was found to increase in digital methods (n=208, 96.7%) and it provided convenience to the dentist (n=215, 100%) compared to traditional methods and 3D technology. 52.1% (n=112) of the students thought that 3D technology increased learning compared to the traditional methods (Table 6).

## Discussion

In dental education, lecture notes, demonstrative models, videos, and presentations are primarily used as educational materials for both practical and theoretical lessons. However, with the development of technology, 3D models and digital education methods have gradually begun to outperform the classical methods.[14]

Currently, the usage frequency of tablets and mobile phones in the learning process is high. In addition, with the increasing use of 3D technology, the concepts of space and direction are developing rapidly, and permanent knowledge about the functioning of anatomical structures is increasing, especially in the fields of medicine and dentistry.[15,16]

In this study, the students were observed to be using social media and digital technologies, as well as traditional lecture notes, to access knowledge. Moreover, some digital technologies became better known as the age increased. Therefore, the null hypothesis is rejected.

Obtaining feedback on students' learning is essential for their education and self-development. For this purpose, we conducted a survey with 309 undergraduate students to gather feedback about the educational resources they use. Based on the responses received, our study observed that students perceive social media and digital technologies as educational resources alongside traditional course materials. This outcome may be considered to have a potentially positive impact on course curriculum design. In line with our findings, Leung et al.[1] conducted a survey with 234 undergraduate and doctoral students from nine different countries, concluding that student feedback contributes positively to the subsequent learning process.

In our survey study, first-grade students preferred traditional lecture notes (89.3%) rather than Internet-based resources (57.1%) and 3D images on computers (25%) or virtual reality

**Table 6.** Differences between 3D technology and traditional methods

| | Class | | | | | | | | | | Df | Chi-square ($\chi^2$) test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class 1 | | Class 2 | | Class 3 | | Class 4 | | Class 5 | Total | | Chi-square | p |
| | n | % | n | % | n | % | n | % | n | % | n | % | | | |
| Work speed increases with 3D technology compared to the traditional method | 15 | 53.6 | 22 | 57.9 | 50 | 66.7 | 57 | 76.0 | 64 | 68.8 | 208 | 67.3 | 4 | 6.61 | 0.158 |
| 3D technology ensures facilities to dentists in practical workflows | 17 | 60.7 | 23 | 60.5 | 57 | 76.0 | 54 | 72.0 | 65 | 69.9 | 216 | 69.9 | 4 | 4.19 | 0.380 |
| 3D methods need complicated information compared to traditional methods | 10 | 35.7 | 8 | 21.1 | 19 | 25.3 | 32 | 42.7 | 34 | 36.6 | 103 | 33.3 | 4 | 8.18 | 0.850 |
| Traditional methods are easier and understandable than 3D technology | 0 | 0.0 | 7 | 18.4 | 9 | 12.0 | 12 | 16.0 | 14 | 15.1 | 42 | 13.6 | 4 | 5.86 | 0.210 |
| 3D technology increases learning compared to traditional methods | 9 | 32.1 | 13 | 34.2 | 25 | 33.3 | 29 | 38.7 | 36 | 38.7 | 112 | 36.2 | 4 | 0.98 | 0.913 |

Chi-square ($\chi^2$) test was used. Df: Degrees of freedom. 3D: Three-dimensional.

(21.4%). When comparing efficient learning techniques, the preferred method was face-to-face learning (71.4%). YouTube videos are used more frequently in practical lessons than traditional or three-dimensional (3D) learning methods. When comparing the use of resources among the first class and the fifth class, it was concluded that the use of 3D technology for learning methods increased in the fifth class. In contrast to our study, de Boer et al.[10] compared 2D and 3D learning methods in 124 first-year dental students and concluded that 3-dimensional learning was more efficient than 2-dimensional learning and 90% of the students preferred three-dimensional learning in the survey in the first class.

Inquimbert et al.[17] compared the learning skills of 206 third, fourth and fifth-year dentistry students with a survey study by watching videos prepared for the lesson, self-study using interactive software, clinical photos, viewing platforms, such as YouTube, before the compulsory face-to-face course and found that video-based education was the best. The three most interesting video sections were prosthodontics, periodontology, and endodontics. Most students engaged in Internet research before lectures. Contrary to the results of this study, the most efficient and preferred learning technique was found to be face-to-face learning. Although students frequently utilize online resources, self-study and social media platforms for their learning, it remains an indisputable fact that traditional face-to-face education continues to play a highly significant role in effective learning. Tain et et.[18] conducted a study on dental students' perceptions of learning resources. They evaluated the learning resources that students benefited from, such as instructor-guided, online, or individual-guided resources, and found that students mostly needed instructor-guided resources for better learning. Consistent with the previous study, the number of those who thought the video-sourced training method was efficient was 122, while the number of those who thought that face-to-face practical training was advantageous was 240 in our study.

It was observed that as age increased, 3D learning tools became more common, and the level of knowledge about their place in dentistry increased in our study. However, Poblete et al.[6] evaluated 3D learning tools and the place of virtual reality systems in dental education using a survey of senior students, graduates, and academicians and found that people benefited from virtual reality and 3D systems in terms of joints, anesthesia, head-neck anatomy, and occlusion, and that this benefit was not significantly different between graduates and students.[5]

Mahrous et al.[19] administered a survey to 80 first-year students to compare extracted teeth, 3D printed models and augmented reality models of dental anatomy. Based on the survey results, they concluded that learning from the extracted teeth was quite advantageous. The models obtained from the 3D printer are easy to use; however, augmented reality is the most interesting learning method. They also concluded that 3D learning perceptions were better for those who had played video games before and were close to 3D technology. Ha and Choi[14] conducted a survey with 72 students and investigated the effect of 3D applications on learning. They found that learning using 3D models was much more effective than learning using classical methods. McMillen et al.[20] evaluated dental structures using physical and visual models and found that physical models were more comprehensible than visual models for understanding tooth structures. Petre et al.[21] conducted a survey on the opinions of dental students on digital and 3D printed models in education, and positive feedback was provided by the students. The experience with digital technology in the preclinical stage was reported to ensure better clinical performance in the future for students. In accordance with the previous studies, the number of participants who thought that learning by watching demonstrations using models was more advantageous than using 3D models with virtual reality in our study. This might be due to the fact that virtual reality is not always applicable in practical lessons, and it is thought to be a guess in line with the experience and knowledge gained only from computer games or social media sources.

When the results of our study were compared, it was observed that the lecture notes of faculty members were mostly used as the primary source of course content. In addition, various Internet resources and YouTube videos were also utilized at high rates. One possible explanation for students' tendency to rely on online resources or social media videos may be their preference for supplementary explanations that complement traditional instruction. Additionally, students may perceive digital technologies as more convenient and accessible tools for learning in today's increasingly digital environment. This tendency might also reflect evolving study habits, where concise and visually engaging materials are sometimes favored over more time-intensive reading and in-depth study. Furthermore, it is important to consider that students' inability to evaluate the reliability of online resources may contribute to the dissemination of inaccurate information, ultimately reducing the quality of education. To mitigate such risks, preparing and uploading clear, accurate educational videos through official university platforms may help prevent

information overload and confusion among students. Moreover, in today's technologically advanced world, where 3D information systems are becoming increasingly common, integrating 3D learning technologies into the curriculum could enhance course effectiveness and engagement.

The limitations of this study were the limited sample size and 3D technology that could not be visually demonstrated and tried, such as virtual reality glasses, 3D printed models, or CAD/CAM products. The increase in awareness of students after the survey should be evaluated.

## Conclusion

The findings revealed that, in addition to lecture notes, students frequently used social media platforms and internet-based resources to support their learning. The level of awareness regarding 3D digital technologies increased progressively from first-year to fifth-year students, indicating a growing familiarity with advanced digital tools over time. Overall, students demonstrated a moderate to high level of awareness of educational technologies, influenced by both their year of study and the accessibility of digital platforms. Integrating these technologies into the curriculum may therefore enhance educational effectiveness and align learning methods with students' evolving preferences.

**Ethics Committee Approval:** The Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee granted approval for this study (date: 14.06.2023, number: 06-293).

**Informed Consent:** Informed consent was obtained.

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