

Teledentistry in pediatric dentistry: Postgraduate dental students' knowledge, practice, and attitudes

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Abstract

Objective: This study aimed to investigate postgraduate pediatric dental students' knowledge, practice, and attitudes toward teledentistry and identify potential applications of this technology in pediatric dentistry.

Methods: An online questionnaire was sent to all students through Google Forms. The questionnaire included questions about socio-demographic information, knowledge, practice, and attitudes regarding teledentistry and the use of teledentistry during coronavirus disease 2019.

Results: Before the coronavirus disease 2019 pandemic, only 8.2% of students knew teledentistry. However, this increased to 45% after the pandemic, with differences depending on the student's clinical experience. Teledentistry was reported as useful for medicine taking, follow-up consultations, and diagnosing soft tissue problems.

Conclusions: Integrating teledentistry topics into the dental curriculum can increase awareness and adoption of this technology in pediatric dentistry. Dental students need to be aware of its potential applications.

Keywords

Coronavirus disease 2019, healthcare, pediatric dentistry, teledentistry, dentistry curriculum

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Introduction

Teledentistry combines dentistry with virtual communication technologies such as computers, cameras, and the Internet. This approach offers consultation, diagnosis, treatment planning, and dental care for patients not physically present at a dental office.¹ There are two modalities of teledentistry: Synchronous (real-time consultation) and asynchronous (store-and-forward method), which enable interactions between dental professionals and patients by forwarding clinical information, radiographs, photographs, and laboratory tests to specialists for consultation.² Other teledentistry applications include remote monitoring of treatment progress, providing preventive care and dental education programs, and delivering oral healthcare services.^{3,4}

Teledentistry has proven effective in almost all dental fields, including orthodontics, oral surgery, dental

traumatology, and pediatric dentistry. Previous studies have evaluated the utilization and efficacy of teledentistry in different fields, reporting that this tool could enhance oral healthcare delivery.^{5–9} For instance, a recent study indicated that using teledentistry for orthodontic treatment follow-up reduced the number of appointments and shortened the treatment time by improving appliance tracking.¹⁰ Another study compared the diagnostic accuracy of teledentistry and clinical dental examination in pediatric dentistry,

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finding no significant difference between the two assessment methods.¹¹

During the coronavirus disease 2019 (COVID-19) pandemic, dental professionals have increasingly adopted teledentistry to provide remote consultations, triage services, drug prescriptions, and specialist referrals.^{12–14} This approach has effectively reduced the transmission risk of COVID-19 to patients and staff by minimizing face-to-face interactions and waiting times.^{15,16} Studies evaluating patients' opinions on the use of teledentistry during COVID-19 have reported that patients have had a mostly positive experience with this system, and it will continue to be helpful after the pandemic.^{17,18} Another study investigated the attitudes of dentists and patients towards teledentistry, revealing that the majority of survey participants expressed positive views toward this approach.¹⁹

Although teledentistry has many advantages, there are also some notable limitations. Most patients need procedural activity such as fillings, extractions, and examination, which can be performed only in the clinic.¹ Teledentistry should be viewed as a supplementary tool to augment accessibility to primary dental services rather than a substitute for comprehensive dental care. The limitation of the teledentistry of delivering dental care is that one can perform limited activities, including screening, consulting, history taking, and triaging. From a diagnostic point of view, it may be beneficial in obtaining a differential diagnosis. Still, palpation and diagnostic tests cannot be applied, and radiographic evaluation cannot be made.^{1,5} Therefore, definitive diagnoses may not always be reached. Teledentistry is disadvantaged in urgent conditions, characterized by severe dental pain stemming from pulpal inflammation, extensive caries, abscess or localized bacterial infection, or tooth fractures causing distress because of the limited availability of timely dental care. An office visit is still required if a personal examination or treatment is necessary.^{5,12}

Although most studies have demonstrated the benefits of teledentistry, many dentists and dental students may need to be aware of its potential applications. Therefore, it is critical to comprehensively assess clinicians' *actual* attitudes and perspectives regarding this approach to determine its routine applicability. In consideration of the increasing significance of teledentistry and its potential to improve dental care delivery, the present study aimed to explore the knowledge, practice, and attitudes of postgraduate students in pediatric dentistry toward this technology and to identify the potential procedure where teledentistry may be helpful in the clinical practice of pediatric dentistry.

Materials and methods

Study design and participants

A cross-sectional study investigated the knowledge, practices, and attitudes of postgraduate pediatric dentistry

students in pediatric dentistry specialty/doctorate programs in 5 different faculties in Ankara, Turkey. The study was conducted by the Declaration of Helsinki and approved by the Institutional Review Board of the Faculty of Dentistry at Gazi University under application number 2021.06/5.

The online questionnaire was distributed to 127 postgraduate pediatric dentistry students in Ankara via the Turkish Pediatric Dentistry Association listserv between April 2021 and July 2021. A social media application (WhatsApp™ Messenger, Mountain View, CA) was used to share the questionnaire link. The survey was open for 3 months, and the data were collected using Google Forms. A reminder message was sent to all postgraduate pediatric dental students on the list at regular intervals (once a month) to increase the participation rate.

Before participation, the participants were provided with a brief introduction, which included an invitation to participate, a summary of the study, an informed consent form, and a confirmation that all information collected would remain confidential. Participation was voluntary. The inclusion criteria considered all postgraduate dental students in the Department of Pediatric Dentistry who were willing to participate.

Questionnaire

The questionnaire consisted of 21 questions, adapted from similar studies,^{20–22} and included closed-ended and single-select (Yes/No) questions. Only the last two questions were created so that more than one answer could be given. A pilot study was conducted with a group of 15 postgraduate pediatric dental students, and the survey was administered twice with a 1-week interval between each administration. The questionnaire was modified based on the pilot study results.

The questionnaire included three parts. The first part collected socio-demographic information, including gender, age, the year of postgraduate education, and daily internet usage time. The second part started with two questions: "Have you ever heard of teledentistry?" and "Do you know what teledentistry is?" The participants were then asked a question regarding the definition of teledentistry, followed by 13 questions to evaluate their attitudes and practice regarding previous experience, benefits of teledentistry, dental practice improvement through teledentistry, the use of pediatric dentistry, the use of teledentistry in dental education, and willingness to use teledentistry in the future. The third section comprised three questions regarding the use of teledentistry during the COVID-19 pandemic. Finally, two questions were asked about which procedures teledentistry can be used in pediatric dentistry and the barriers to using teledentistry.

Statistical analyses

The data were analyzed using IBM SPSS Statistics V23 (IBM Corp., Armonk, NY, USA). Descriptive statistics

included frequency distributions. Fisher's Exact and Pearson Chi-Square tests were used to evaluate their knowledge, attitudes, and practice about teledentistry according to socio-demographic variables. The Bonferroni corrected Z test was automatically performed by the SPSS program to show which subgroups caused the difference in the results that were found to be significant due to the Pearson Chi-square test. In pairwise comparison, he multiplies the p value obtained by the number of multiple comparisons and tests the significance of the obtained p values at the 5% significance level. Analysis results were presented as frequency (percentage) for categorical variables, mean \pm standard deviation, and median (minimum–maximum) for quantitative variables.

Results

One hundred twenty-seven questionnaires were distributed to postgraduate pediatric dental students, and 110 replies were received from Google Forms, indicating a response rate of 86.6%. The participants had a mean age of 28.8 ± 5.8 years (range: 21–35 years), and the majority were female (90.9%). Demographic information on the study participants is provided in Table 1. Table 2 displays the

Table 1. Frequency distributions and descriptive statistics of the participants' characteristics.

Variable	N	%
<i>Gender</i>		
Female	100	90.9
Male	10	9.1
<i>The year of postgraduate education</i>		
1	25	22.7
2	23	20.9
3	23	20.9
4	7	6.4
5	5	4.5
6	27	24.5
<i>Daily internet usage time</i>		
0–2 h	6	5.5
2–4 h	64	58.2
4–6 h	40	36.4

responses of participants' knowledge, attitude, and practice regarding teledentistry, as well as its association with the year of postgraduate education.

The participants' knowledge of teledentistry was revealed; only 47.3% had heard about it, and 45.5% knew what it was. Significant differences were found depending on dental students' years of clinical experience ($p < 0.05$). The knowledge of first-year postgraduate students about teledentistry was the lowest, while fifth-year postgraduate students had significantly higher knowledge about teledentistry than first-year postgraduate students ($p = 0.012$).

Regarding the practice of teledentistry, 70% of the subjects reported talking to a patient (photograph, video, etc.) using a smartphone or camera, with no significant differences based on years of experience ($p < 0.05$). When asked about their intention to use teledentistry in the future, 88.2% expressed interest in practicing it, with no significant differences based on the year of education ($p > 0.05$).

Most participants (96.4%) agreed that teledentistry could be applied in pediatric dentistry and help pediatric patients consult a specialist about their problems. Almost 91.8% of participants believed teledentistry could improve access to oral healthcare services for pediatric patients, particularly in rural areas, and help provide oral hygiene instructions to pediatric patients. While most participants (96.4%) believed that teledentistry could be used in addition to routine checkups provided by the pediatric dentist, only 8.2% of the participants agreed that dental examination using teledentistry is as effective as traditional examination in the office environment. The year of education was significantly associated with the inclusion of teledentistry in the curriculum ($p < 0.05$).

Before the COVID-19 outbreak, only 8.2% of participants knew teledentistry. However, 98.2% of participants believed that using teledentistry during the COVID-19 outbreak could reduce the risk of spreading the virus. 54.5% of participants stated that teledentistry could be a standard way of oral healthcare after the COVID-19 outbreak, with significant differences depending on participants' years of education ($p < 0.05$). A statistically significant difference was observed between the answers of the participants in their second year of education and those in their sixth year.

Table 3 presents only questions with statistically significant correlation among the participants' knowledge, attitudes, and practice results regarding tele-dentistry, and its relationship with gender and daily internet usage time. There was no statistically significant difference between the other questions and the participant's knowledge, attitude, and teledentistry practice. Table 4 demonstrates that infrastructure (84.5%) was reported as the biggest obstacle to teledentistry by participants, followed by patient compliance and satisfaction requiring the physical presence of the dentist (70%) and the low education level of the population (65.4%).

Table 2. Responses of participants' knowledge, practice, attitude to use teledentistry, and the use of teledentistry during the coronavirus disease 2019 (COVID-19) pandemic and its association with the year of postgraduation education.

Questions	% of "Yes" Answers based on the year of postgraduate education							p-Value*
	Total	1st year	2nd year	3rd year	4th year	5th year	6th year	
<i>Knowledge items</i>								
Q1. Have you ever heard of teledentistry?	47.3	20 ^a	56.5 ^{a,b}	56.5 ^{a,b}	28.6 ^{a,b}	100 ^b	51.9 ^{a,b}	0.015
Q2. Do you know what teledentistry is?	45.5	16 ^a	47.8 ^{a,b}	56.5 ^{a,b}	42.9 ^{a,b}	100 ^b	51.9 ^{a,b}	0.012
Q3. "Teledentistry is the practice of using computers, internet, and technologies for dental consultation and treatment advice over a distance." Do you agree with this definition?	92.7	96	95.7	91.3	85.7	100	88.9	0.895
<i>Practice items</i>								
Q4. Have you ever talked to a patient (photograph, video, etc.) using a smartphone or camera?	70	40	82.6	100	100	100	74.1	0.051
Q5. In the future, will you practice teledentistry?	88.2	92	73.9	87	85.7	100	96.3	0.295
<i>Attitude items</i>								
Q6. Can teledentistry be applied in pediatric dentistry?	96.4	100	95.7	91.3	100	100	96.3	0.795
Q7. Can teledentistry help pediatric patients consult a specialist about their problems?	96.4	100	100	91.3	100	100	100	0.853
Q8. Can teledentistry provide early and easy consultation with an expert?	98.2	96	100	95.7	100	100	100	0.853
Q9. Can teledentistry improve access to oral healthcare services for pediatric patients, particularly in rural areas?	91.8	92	95.7	87	85.7	100	100	0.590
Q10. Can teledentistry be a good tool for giving oral hygiene instructions to pediatric patients?	91.8	96	95.7	91.3	85.7	100	85.2	0.755
Q11. In teledentistry, in pediatric patients, is dental examination through online video calls and intraoral cameras as effective as in a traditional office environment?	8.2	13	13	8.7	0	20	0	0.041
Q12. Can teledentistry help monitor the pediatric patient's oral health?	94.5	100	91.3	95.7	85.7	80	96.3	0.402
Q13. Can teledentistry be used in addition to routine checkups provided by the pediatric dentist?	96.4	100	95.7	91.3	100	100	96.3	0.795

(continued)

Table 2. Continued.

Questions	% of "Yes" Answers based on the year of postgraduate education							p-Value *
	Total	1st year	2nd year	3rd year	4th year	5th year	6th year	
Q14. Is teledentistry a time saver for patients and dentists?	91.8	96	95.7	82.6	100	100	88.9	0.543
Q15. Can teledentistry be used for the training and continuing education of dentists?	55.5	60	60.9	39.1	100	60	48.1	0.124
Q16. Would you like to be added to the curriculum of teledentistry?	90	100 ^a	95.7 ^{a,b}	87 ^{a,b}	100 ^{a,b}	60 ^b	81.5 ^{a,b}	0.030
<i>The use of teledentistry during the COVID-19 pandemic</i>								
Q17. Did you know teledentistry before the COVID-19 outbreak?	8.2	8	4.3	8.7	28.6	0	7.4	0.570
Q18. Does reducing the risk of spreading the virus by using teledentistry practice during COVID-19 outbreak?	98.2	100	95.7	95.7	100	100	100	0.829
Q19. Do you think teledentistry can be a standard way of oral health care after the COVID-19 outbreak?	54.5	48 ^{a,b}	82.6 ^b	52.2 ^{a,b}	85.7 ^{a,b}	40 ^{a,b}	33.3 ^a	0.011

* Pearson Chi-Square test was used for data analysis, Statistically significant are indicated with different superscript uppercase letters ($P < 0.05$).

Table 3. Responses of participants' knowledge, practice, attitude to use teledentistry, and the use of teledentistry during the coronavirus disease 2019 (COVID-19) pandemic and its association with gender and daily internet usage time.

Questions	% of "Yes" answers based on gender and daily internet usage time							Value** p-
	Male	Female	p-value*	0-2 h	2-4 h	4-6 h	Value** p-	
Q8. Can teledentistry provide early and easy consultation with an expert?	99	99	0.174	83.3 ^a	100 ^b	97.5 ^{a,b}	0.013	
Q13. Can teledentistry be used in addition to routine checkups provided by the pediatric dentist?	80	98	0.041	100	96.9	95	0.784	

*Fisher's exact test, **Pearson Chi-Square test were used for data analysis, statistically significant are indicated with different superscript uppercase letters ($P < 0.05$).

Table 5 illustrates the potential procedures for which teledentistry might be useful in pediatric dentistry practice. Most participants rated prescribing medication (96.4%), follow-up consultations (92.7%), and soft tissue problems (91.8%) as *essential* uses for teledentistry in clinical practice. Other procedures that were rated highly included space maintainer issues (75.5%), abscesses/swelling (24.5%), pain (11.8%), and trauma (10.9%).

Discussion

The twenty-first century has brought significant changes to the healthcare industry, including the adoption of digital

health solutions that have the potential to improve the efficiency, accessibility, and quality of healthcare services. Healthcare providers must adapt to this technological shift, and these solutions must be effectively integrated into existing healthcare systems.²³ In recent years, the dental profession has witnessed a significant surge in the adoption of communication systems and information-based technologies, which have introduced novel paradigms for promoting and preventing oral health.²⁴ Teledentistry is a technological advancement that can improve access to dental care services and enhance time management for dental practitioners and patients.²⁵ Although teledentistry is not a new discipline, the emergence of the COVID-19

Table 4. Responses of the participants about the barriers faced in teledentistry (Q20).

	N	%
Long time for dentists to learn and apply this technology	27	24.5
Patient privacy	43	39
Patient compliance and satisfaction requiring the physical presence of the dentist	77	70
Infrastructure deficiencies	93	84.5
The low education level of the population	72	65.4

Table 5. The participants' responses regarding the procedures in which teledentistry can be used in pediatric dentistry (Q21).

	N	%
Prescribing medication	106	24.5
Follow-up consultation	102	92.7
Soft tissue problem	101	91.8
Problems of space maintainers	83	75.5
Abscess/swelling	27	24.5
Pain	13	11.8
Trauma	12	10.9

pandemic has raised attention to its crucial role as a tool for delivering dental services without the risk of infection.^{26,27}

To the best of our knowledge, the first teledentistry system in Turkey was established in the Department of Pedodontics at the Faculty of Dentistry of Necmettin Erbakan University. Abaklı İnci et al.¹⁷ to investigate the satisfaction of parents who received teledentistry service in a pediatric dentistry clinic during the COVID-19 pandemic reported that parents benefited greatly from this technology and would be open to using it after the pandemic. They also reported that teledentistry systems, which offer significant benefits to patients and dentists in pediatric dentistry, are expected to become commonplace soon. Therefore, evaluating the knowledge, practice, and attitudes of postgraduate pediatric dental students who will use this technology is essential.

There are two postgraduate education programs in dentistry faculties in Turkey (1) Specialization (2) PhD The PhD program takes a minimum of 4 years, but an extension of up to 8 years can be taken. However, the specialization

program lasts for 4 years, and it can be extended for 1–2 years depending on the student's academic performance. Since both education programs have theoretically similar curricula, this distinction was not made during the collection of demographic data.

In the present study, nearly half (47.3%) of the postgraduate pediatric dental students had some knowledge of teledentistry. However, one study²¹ found that only 17.2% of dental students were aware of this technology. Similarly, the other study²⁸ revealed that 57.1% of private dentists had never heard of teledentistry. Before the COVID-19 pandemic, the knowledge of teledentistry was relatively low (8.2%); however, the current study observed an increase in awareness, with 45% of participants indicating some understanding of this technology. This finding is consistent with previous studies that have reported an increase in knowledge of teledentistry during the COVID-19 pandemic despite low levels of awareness before the pandemic.^{1,29} Nonetheless, it is worth noting that almost half of the current study participants needed more teledentistry knowledge. Recent research^{20,21,30} has demonstrated that this is a common trend among dental students, likely due to a lack of training in the dental curriculum. Therefore, integrating teledentistry into the curriculum could help to bridge the knowledge gap.

Moreover, the present study found significant differences in the level of knowledge of teledentistry among postgraduate dental students, depending on their year of education ($p > 0.01$). Specifically, as the education year of the students increased, their knowledge of teledentistry also increased. Students in their fifth year of education had significantly higher levels of knowledge than those in their first year. This finding is consistent with a recent study that reported a significant association between years of clinical experience and better knowledge ($p > 0.01$), with specialists demonstrating significantly better knowledge than dentists and students.²⁶

Despite the potential benefits of teledentistry, its adoption by dental practitioners has been limited.^{26,31} It is worth noting that most participants (70%) in the current study reported conducting dental consultations via video/photograph calls with patients using a smartphone or camera. This trend was likely due to the COVID-19 lockdown, which limited in-person consultations. Additionally, many dentists relied on telephone communication to stay connected with their patients, answer emergency calls, and send prescriptions as needed.²⁸ Before the COVID-19 pandemic, the practice of teledentistry among dentists in Canada was low, but it increased during the pandemic, as reported in one study.¹

Most of the participants in this study exhibited positive attitudes toward the benefits of teledentistry. They acknowledged that teledentistry provides easy and early consultation to pediatric dentists, facilitates access to oral health services for pediatric patients living in rural areas, is a

valuable tool for giving oral hygiene practices, helps monitor the pediatric patient's oral health, and saves time for dentists and patients. These findings are consistent with a previous study investigating the knowledge, attitude, and awareness of dentists and dentistry students towards teledentistry.²² The perceived need for teledentistry among dental students during the COVID-19 pandemic may have contributed to these positive attitudes.

However, the study participants also expressed challenges in using teledentistry. Only 8.2% of the participants reported that dental examination using teledentistry in pediatric patients could be as effective as in a traditional office environment. However, a systematic review has reported that teledentistry has an acceptable diagnostic performance in detecting dental caries.³² In a recent study on the remote management of emergencies with intraoral photographs in the pediatric dentistry department during the COVID-19 lockdown, 93% of cases were accurately diagnosed using teledentistry alone.³² A recent study³³ evaluated the reliability of teledentistry in the diagnosis and treatment planning of dental caries in children in mixed dentition. They reported that the reliability of teledentistry is higher in primary teeth than in permanent teeth, and it offers acceptable reliability for the initial diagnosis of caries in children.

Teledentistry has been reported to be a valuable tool in pediatric dentistry for consultation, patient triaging, treatment planning, and follow-up purposes.³³⁻³⁵ In this study, most participants (96.4%) agreed that teledentistry should be applied in pediatric dentistry. When asked which procedures teledentistry can be used for in pediatric dentistry, participants reported that it could be chiefly used in prescribing medication, follow-up consultation, and soft tissue problems. One study³⁵ evaluated the implementation of teledentistry in pediatric practice during the COVID-19 pandemic and reported that the highest utilization of teledentistry was for eruption concerns and other issues such as ankyloglossia and aphthous ulcers. Teledentistry has uses and implications beyond the triage of acute dental emergencies.

In this study, 55% of participants reported that teledentistry could be *helpful* for dentists' training and continuing education. Additionally, teledentistry was found to be a valuable educational resource among postgraduate pediatric dental students, supplementing traditional teaching methods. Its applications extend beyond education, providing a secure and confidential platform for case discussions, which allows multiple users to interpret clinical cases related to diagnosis and treatment.^{36,37} Recent literature has demonstrated that real-time teledentistry consultations can effectively improve learning for dental students and healthcare professionals. Integrating teledentistry into dental education can enhance student learning, perception, and motivation.³⁸

While many countries have adopted teledentistry in the face of a surge in cases of COVID-19, the overall adoption

of teledentistry has been slow and inconsistent *worldwide*. While developed countries continue to benefit and expand this technology, teledentistry in developing countries is still in its infancy.^{16,39} Therefore, it can be assumed that many developing countries, especially in the suburban and remote regions, *face* a lack of teledentistry for *using* this technology in daily practice due to the lack of infrastructure, professional readiness, and patients with low technology literacy.¹⁶ Infrastructure deficiencies have been identified as one of the primary barriers to adopting teledentistry, with 84.5% of respondents highlighting this as a challenge. Despite this, a teledentistry system for pediatric dentistry departments in Turkey has been established. Integrating teledentistry topics into dental curricula is recommended to raise awareness and increase the adoption of this technology among postgraduate dental students. Most participants (90%) desired to add teledentistry to the curriculum, with 88.2% stating they would be willing to use it. These results are similar to those of prior studies.^{26,40}

This study has several limitations. The low response rate of students in the fourth and fifth years of postgraduate pediatric dentistry education is a limitation. While the doctoral program was suspended during the pandemic period in our faculty, the specialization program was continued. The decrease in the number of students *because* the training period of the specialization program is more limited in this period may have caused this situation. Therefore, we are cautious in assuming the generalizability of the study findings. In addition, while investigating the potential applications of this technology in pediatric dentistry in the study, more positive results were reflected by focusing on non-invasive applications that can be diagnosed/resolved using teledentistry. It is important to emphasize that dental care opportunities are limited with teledentistry, *emergencies* (abscess, pulpal inflammation, etc.), and operative and preventive dentistry practices. It may be stressed that teledentistry may be beneficial in obtaining a differential diagnosis from a diagnostic perspective, but from a treatment perspective, the benefits may be overrated. Although we have identified potential applications where teledentistry is most likely to be used, more research is needed to delve deeper into the use of these applications.

Teledentistry is an effective tool for oral health planning and patient management. Incorporating teledentistry into the curriculum and exposing postgraduate pediatric dental students to its use during their training may increase the likelihood of dentists using this technology in their practice. With the increasing use of teledentistry during the COVID-19 pandemic, providing more information about its application areas and use is vital, leading to greater adoption by specialists. This study provides a basis for further research and development and can inform future efforts to promote teledentistry in pediatric dental practice.

Conclusion

In conclusion, the study results demonstrate a lack of knowledge of teledentistry among postgraduate pediatric dental students. Therefore, there is a need for greater awareness and education about teledentistry among these students. However, most postgraduate pediatric dental students exhibit positive attitudes towards teledentistry. To prepare *teledentistry* for pediatric dentists to use in their practice and facilitate patient care, the practice of teledentistry should be integrated and emphasized in the dentistry curriculum.

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