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Knowledge and skills of paramedics in handling patients with traumatic dental injuries

Introduction: Traumatic dental injuries are sudden and acute events and often require emergency care. Paramedics are very often the first responders on the scene. Through rapid and correct management, they can have a significant impact on the prognosis of the injured tooth. This study aimed to investigate the knowledge and skills of paramedics in the management of dental injuries.

Methods: In this cross-sectional observational study, an electronic questionnaire was sent to 541 emergency departments across Germany. The questionnaire contained questions about the characteristics of the paramedics and about their ability to treat dental trauma. For statistical analysis, the Student's t-test, the chi^2 test, the ANOVA test, or a regression model were used, as appropriate.

Results: Only 6% of the 690 participants reported having at least a good working knowledge, and only 4.5% reported having good dental trauma management skills. Although 79% of participants felt that an intraoral examination was an essential part of the initial examination of trauma patients, only 15.66% were familiar with this procedure. And although 71.9% of participants had heard of a dental rescue box, only 30.7% carried one as standard equipment on the rescue vehicle.

Conclusion: Paramedics have only a basic understanding of the treatment of dental trauma. Initial treatment of dental trauma should become an integral part of paramedic training. Dental rescue boxes should be standard equipment on ambulances. In general, a good long-term outcome should be sought for patients with dental trauma. Paramedics could play an important role in the care of dental trauma patients.

Keywords: avulsion; dental rescue box; knowledge; paramedics; skills; traumatic dental injury

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Variable (n)		Number (%)
Age Mean/Median [Min-Max] in years (677)	32.8 ± 10.5/30 [14–62]	677
Gender (673)	Male	501 (74.4)
	Female	170 (25.3)
	Diverse	2 (0.3)
Kind of paramedics (659)	Notfallsanitaeter/ Rettungsassistenten*	479 (72.7)
	Rettungssanitaeter**	163 (24.7)
	Rettungsdiensthelfer***	14 (2.1)
	Others	3 (0.5)
Training completed (675)	Yes	598 (88.4)
	No	77 (11.6)
Experience in EM Mean/Median [Min–Max] in months (670)	111.4 ± 106,8/72 [0–480]	670
Amount of Exposure to TDI per month (670)	0	462 (69)
	1–10	158 (23.6)
	11–20	8 (1.2)
	>20	9 (1.3)
	No Information given	33 (4.9)
Family member as a dentist (659)	Yes	19 (2.9)
	No	640 (97.1)

Table 1 Characteristics of the participants, abbreviations: n = number; EM = emergency medicine; TDI = traumatic dental injury; * "Notfallsanitäter/Rettungsassistent" = highest nonmedical qualification in the rescue service in Germany with 3 years/2 years of apprenticeship; ** "Rettungssanitäter" = emergency service personnel with 520 hours of training, work as a team partner of the "Notfallsanitäter/Rettungsassistent" or in ambulance transport; *** "Rettungsdiensthelfer" = 320 hours of training, as partner of the "Rettungssanitäter" in ambulance transport or partner of the "Notfallsanitäter/ Rettungsassistenten" in emergency service

1. Introduction

Traumatic dental injuries (TDI) are sudden and acute events and often require emergency care. Oral injuries account for approximately 5% of all bodily injuries in adults, although the oral region comprises only a small body surface area of 1% [21]. Unfortunately, TDI are still neglected, probably because there are no standardized diagnostic, classification, or registration systems. Properly registered, they rank fifth among the most common diseases and acute injuries [21]. The prognosis of an injured tooth depends on the rapid initiation of proper treatment of dental trauma [2, 17]. Delayed treatment leads to more complications and additional costs [1]. In international studies, emergency physicians have shown little knowledge and inadequate skills in the management of TDI [25]. However, paramedics are usually on the scene before the emergency physician. Their rapid and correct management can have a decisive impact on the prognosis of the injured tooth. The aim of this study was to investigate the knowledge and skills of paramedics in the management of TDI.

2. Patients and methods

2.1 Participants

This study was submitted to the local ethics committee (No. 28/2/20) and was classified as a survey study of emergency professionals; therefore, no ethical review was required for it.

A total of 541 rescue stations in Germany were contacted by e-mail with a request to participate in this study. All possible available addresses of state, regional and local associations were selected and all major rescue service organizations (434 addresses; Malteser, Johanniter-Unfall-Hilfe, Deutsches Rotes Kreuz, Arbeiter-Samariter-Bund) and professional fire departments nationwide (107 addresses) were contacted. Private companies and volunteer fire departments were not contacted. A cover letter explaining the nature and purpose of the study and clearly emphasizing its voluntary nature was sent to the designated contact person at each rescue station, along with a link to an electronic survey. Distribution of the link to the entire staff was done by this designated contact person. Return of the questionnaire implied informed consent from the participants. Confidentiality was ensured as the questionnaire did not collect names or contact information of the participants. Due to the anonymity of the questionnaires, it is not technically possible to determine a response rate per ambulance station or an overall response rate. All participants were employed in the ambulance service during the study period from November 1, 2020 to January 15, 2021 and belonged exclusively to the non-medical personnel in the ambulance service.

Included as participants were emergency paramedics/rescue assistants ("Notfallsanitäter"/"Rettungsassistent", in Germany the highest non-medical qualification in rescue services, 3 years/2 years of training). In addition, the participants were "paramedics" ("Rettungssanitäter", 520 training hours), who work in a team with emergency paramedics/ rescue assistants or in patient trans-

port, and "rescue service assistants" ("Rettungsdiensthelfer", 320 training hours), who work together with paramedics in patient transport or with emergency paramedics/rescue assistants in rescue service.

For simplicity, the participants in this study are referred to as paramedics, although the various paramedic professions in Germany cannot be directly compared to this job description worldwide.

2.2 Survey

The survey was developed based on previous studies [4, 20, 24, 26]. The electronic questionnaire was created using the program Kwiksurveys®, Problem Free Ltd, Portishead, Bristol, UK (www.kwiksurveys.com). It was designed so that participants could complete only one questionnaire at a time and duplicate completion was precluded. The questionnaire consists of two parts. Part 1 collected personal information such as age, gender, professional experience, type of emergency service, level of training, self-assessment of one's knowledge and skills in the treatment of dental trauma and intraoral examination, presence of a dentist in the family, interest in learning to treat dental trauma, desired training resources, and approximate TDI cases per month. In the second part, specific questions were asked about the estimated time relevance of TDI care, knowledge and approach to intraoral examination, proper tooth retention medium, and procedures for treating avulsed, dislocated, and fractured teeth. There were 18 questions, which were incorporated into a knowledge score following the study by Yigit et al. [26]. Zero to 8 correctly answered questions indicated an inadequate level of knowledge, 9 to 13 correct answers indicated an intermediate level of knowledge, and 14 to 18 correct answers indicated a high level of knowledge. Some important questions were designed as dependent questions. The participant could only see the follow-up questions if the answer was correct. If the answer was incorrect, the entire set of questions was scored as incorrect. Thus, logical inferences to answers by follow-up questions were avoided.

Variable (n)	Answer	Number (%)
Do you have knowledge about dental trauma management? (Multiple choices possible) 924 answers/689 participants	No	303 (44)
	Yes from books	145
	Yes from training	237
	Yes from advanced training	110
	Yes from clinical experience	68
	Yes from other colleagues	61
How do you rate your knowledge of dental trauma management? (Self-assessment) (686)	Very good	2 (0.3)
	Good	39 (5.7)
	Sufficient	240 (35)
	Inadequate	315 (45.9)
	Have no knowledge	90 (13.1)
How do you rate your practical skills of dental trauma management? (640) (Self-assessment)	Good	29 (4.5)
	Sufficient	198 (31.0)
	Inadequate	324 (50.6)
	Have no skills	89 (13.8)
Are you interested in learning dental trauma management? (688)	Yes	473 (68.8)
	No	26 (3.8)
	Maybe	189 (27.4)
How should the knowledge be conveyed? (686)	Books	31 (4.5)
	Video Demonstration	246 (35.9)
	Oral Training	109 (15.9)
	Hands on Courses	300 (43.7)

Table 2 Questions about dental trauma management. There were questions asked about the knowledge, self assessment of knowledge and skills in dental trauma management, interest in learning dental trauma management and how new knowledge and skills should be presented. abbreviation: n = number of participants

Whether a question had been answered correctly was assessed in each case using the current guidelines for the management of dental trauma published by the International Association of Dental Traumatology [8, 13, 18].

2.3 Statistical analysis

Statistical analysis was performed using SPSS software, version 27.0 (IBM, Armonk, NY, USA). Descriptive analysis including mean, median, standard deviation, minimum and maximum was performed. Student's t-test, chi^2-test or ANOVA test, and linear regression models were used, as appropriate. The significance level was set at $p < 0.05$.

3. Results

A total of 745 questionnaires were received by the Kwiksurveys® program. Due to incompleteness 50 questionnaires and due to a deviating profession of the participant 5 further questionnaires were excluded, so that a total of 690 evaluable questionnaires remained

Question (n)	Answer	Number (%)
Is the intraoral examination an integral part of the examination of trauma patients? (663)	Yes	524 (79.03)
	No	139 (20.97)
Are you familiar with the procedure of an intraoral examination? (664)	Yes	104 (15.66)
	No	188 (28.31)
	Partial	372 (56.02)
Do you know how to detect a) loosened teeth, b) bone fractures in the oral cavity? (666)	Yes a)	230 (34.53)
	No a)	436 (65.47)
	Yes b)	224 (33.63)
	No b)	441 (66.22)
How do you rate your own intraoral examination skills? (665)	Good	22 (3.31)
	Sufficient	225 (33.83)
	Inadequate	370 (55.64)
	Have no skills	48 (7.22)
How do you assess the time relevance for the TDI supply? (680)	High	235 (34.56)
	Medium	322 (47.35)
	Low	80 (11.76)
	I don't know	43 (6.32)
Do you know what a tooth rescue box is? (620)	Yes	446 (71.9)
	No	142 (22.9)
	Not exactly	32 (5.2)
Is a tooth rescue box carried in the ambulance as standard? (618)	Yes	190 (30.7)
	No	428 (69.3)
In general, should patients with dental trauma be presented to a dentist? (613)	Yes	584 (95.3)
	No	10 (1.6)
	I don't know.	19 (3.1)

Table 3 Questions about the intraoral examination and the tooth rescue box. There were questions asked about the importance and the procedure of the intraoral examination, the self-assessment of their ability to perform an intraoral examination and questions about the knowledge and standard equipment of a tooth rescue box in the ambulance; Abbreviations: n = number, TDI = traumatic dental injury; Note the contrast between the importance and the knowledge and skills of an intraoral examination and between knowledge and the standard on an ambulance regarding a tooth rescue box

from the participating paramedics. The regional distribution of returned questionnaires is as follows: 362 (41.3%) from rural regions, 514 (58.7%) from urban regions (303 [59.0%] small town; 211 [41.0%] large city). Fifteen of 16 states were represented. The mean age of participants was 32.8±10.5 years (median 30 years). With 501 (74.4%) male and 170 (25.3%) female participants, the male-to-female ratio was 2.95:1. Over 70% of participants were emergency paramedics/rescue assistants. Table 1 provides an overview of the participants' personal data.

Only 6% of participants reported having good or very good knowledge, and only 4.5% reported having good skills in dental trauma care (Table 2). Although 524 (79%) participants believed that an intraoral examination was an integral part of the trauma patient examination, 188 (28.3%) did not know the exact procedure of an intraoral examination at all, and 372 had only partial knowledge (56%). Only 37.14% of participants rated their intraoral examination skills as good or adequate (Table 3).

Only 15 paramedics (3.0%) knew the correct procedure for replanting an avulsed tooth. Only 18% would choose a physiological nutrient medium for temporary tooth storage; only 10.8% chose the second best alternative, milk. Although 71.9% of participants knew about tooth rescue boxes, only 30.7% reported that a tooth rescue box was part of the standard rescue vehicle equipment (Table 3–5). A similar level of uncertainty was evident when dealing with dental luxations and fractures (Table S1). There were also large regional differences within Germany in the equipment of the ambulance with dental rescue boxes (Table S2).

The second part of the questionnaire assessed expertise in the management of dental trauma with 18 questions that were combined into a knowledge score. The mean score was 10.53±3.5 (median 12) and was considered moderate. More than half of the 622 participants (n = 326; 52.4%) scored moderate, but only 139 participants (22.3%) had a high knowledge score. None of the participants had 18/18 correct answers. Table 6 shows the scores for the different categories.

Almost all participants expressed interest in advanced education on the topic of trauma management in dentistry. A total of 68.8% were clearly in favor of continuing education, and 27.4% could perhaps imagine continuing education in this area. Only 3.8% expressed no interest in advanced education. Practical courses (43.7%) and video demonstrations (35.9%) were most frequently desired (Table 2).

4. Discussion

The management of TDI by paramedics in Germany is poor, with about two-thirds having no or insufficient knowledge and another two-thirds having no or insufficient skills. Almost half of the participants (44%) reported having no prior knowledge of dentistry. These results are consistent with other studies examining paramedics and/or physicians [3, 25]. In the study by Lin et al., none of the participating emergency paramedics had received any training on TDI management [19]. Even though dental trauma is often not the primary concern in an emergency situation, but other injuries requiring care and, in some cases, life-threatening injuries need to be assessed and treated, basic knowledge in the initial management of dental trauma, including knowledge of a dental rescue box, is also important for paramedics. This is also reflected in the content of the current AWMF S3 guideline "Polytrauma/Treatment of Severely Injured", which includes procedures for the treatment of dental and facial trauma and provides guidance on first aid [6]. However, not all patients with dental trauma are polytrauma patients, and knowledge and skills in the treatment of TDI would be desirable outside of polytrauma care too.

Intraoral examination should be routinely performed in trauma patients, especially in the case of head injury. Most (79%) study participants agreed that an intraoral examination is an essential part of the trauma patient exam, but only 15.66% knew the procedure for an intraoral examination. Only one-third knew how to identify tooth loosening or jaw frac-

Table 4 Questions about the knowledge, skills and management of an avulsed tooth. Note the poor results of knowing the procedure and self-assessment of the ability to replant an avulsed permanent tooth; the smaller numbers of participants are caused by the use of dependent questions. Only participants who answered correctly to replant an avulsed, permanent tooth could see and answer the following questions about the further management and their own skills in replanting the tooth. Abbreviations: n = number of participants

Question (n)	Answer	Number (%)
Should avulsed teeth be sought out at the scene of the accident? (659)	Yes	529 (80.27)
	No	26 (3.95)
	I don't know.	104 (15.78)
Should an avulsed a) permanent tooth, b) decideous tooth be replanted? (a) 659; b)653)	a) Yes	513 (77.8)
	a) No	19 (2.9)
	a) I don't know.	127 (19.3)
	b) Yes	62 (9.5)
	b) No	349 (53.4)
	b) I don't know.	242 (37.1)
When should an avulsed permanent tooth ideally be replanted? (500)	As quickly as possible	276 (55.2)
	Within 6h	110 (22.0)
	Within 12h	24 (4.8)
	Within 24h	15 (3.0)
	I don't know.	73 (14.6)
	No matter	2 (0.4)
Where would you touch an avulsed permanent tooth? (501)	Not at all	35 (7.0)
	Crown	465 (92.8)
	Root	1 (0.2)
How would you treat a permanent, avulsed tooth prior to replanting? (497)	Not at all	54 (10.9)
	Thoroughly remove dirt and supply to the correct storage medium	119 (23.9)
	Only supply to a correct storage medium	324 (65.2)
Do you know the procedure for replanting a permanent tooth? (495)	Yes	15 (3.0)
	No	442 (89.3)
	Perhaps	38 (7.7)
How do you rate your abilities to replant a permanent tooth yourself? (491)	Very good	0
	Good	0
	Sufficient	14 (2.9)
	Inadequate	86 (17.5)
	Have no skills	391 (79.6)
Should a patient see a dentist after an emergency replantation? (499)	Yes	464 (93.0)
	No	10 (2.0)
	Perhaps	25 (5.0)
When should this presentation to the dentist take place? (457)	Immediately	255 (55.8)
	Within 24h	98 (21.4)
	Within 1 week	23 (5.0)
	If necessary	3 (0.7)
	I don't know.	78 (17.1)

Storage media (n=500)	Number	(%)
Hypotone saline solution	10	2.0
Hypertone saline solution	6	1.2
Isotone saline solution	142	28.4
Saliva	53	10.6
Milk	**54**	**10.8**
Special nutrient medium	**90**	**18.0**
In a bag	45	9.0
In a dry cloth, gauze	22	4.4
No matter	1	0.2
I don't know	76	15.2

Table 5 Distribution of responses regarding ideal tooth storage media; note the high proportion of "I don't know" compared to the correct answers written in bold (special nutrient medium first choice, milk second choice)

tures. The majority of participants rated their own skills in performing intraoral examination as inadequate or non-existent. This clearly indicates that paramedic training needs to be greatly improved. Participants in this study desired training, preferably in the form of hands-on courses or video demonstrations. This confirms the results of other studies [3, 24], and another study found that 100% of participants stated that this knowledge is important for first aid [11].

Regarding avulsion, the maximum form of dental trauma, the participants of this study showed some basic knowledge. For example, at least 80.27% of the respondents would search for an avulsed tooth at the accident site, and 77.8% would theoretically replant a permanent tooth. Thus, they show much better theoretical knowledge than according to the results of previous studies, in which most participants did not know what a tooth avulsion or a tooth replantation was, or did not even consider replantation as a treatment option [3, 11]. However, the practical skills to perform the replantation of an avulsed tooth are reported to be very poor in all studies (paramedics and/or emergency physicians) [7, 11, 19, 24, 25]. Our results are consistent with these findings, as 89.3% of the participants did not know the replantation procedure and only 2.9% rated their skills to perform replantation as adequate. The remainder rated their skills to perform as inadequate or had no knowledge. No participant reported having good or very good knowledge.

This again shows the urgent need for training or at least support on this topic. A list of local dentists advising paramedics on the proper management of dental trauma, preferably 24/7 by telephone, would be one option that has been suggested previously as a support for emergency physicians [20, 24] and would certainly be useful for the period until the emergency physician arrives on the scene. The very availability of advice on the correct transport medium can dramatically improve the prognosis of the injured tooth. However, this assumes that the dentists involved also have adequate knowledge and skills in the treatment of TDI. Studies have shown that dentists and emergency physicians may lack knowledge [14, 24, 25]. TDI should be considered in the training of first responders, including paramedics. Instruction in the correct diagnosis of TDI coupled with proper skills could lead to a better outcome for the affected teeth [25]. For current practice, tools such as the "Dental Trauma Guide" (www.dentaltraumaguide.org) or the dedicated app "AcciDent ®" should be available for all first responders, including paramedics. With their help, they could react more appropriately to unknown situations.

Given that paramedics and even emergency physicians are so unsure of how to replant a tooth at the scene of an accident, it is even more important to know the correct storage medium for an injured tooth. Then, safe storage of the tooth is possible until the patient arrives at the dentist for further treatment or the patient's condition permits treatment of the teeth. In the present study, only 18% of the respondents selected the correct specific culture medium for temporary storage of the tooth. And even after adding the second best option, milk, only 28.8% of the injured teeth would be properly stored, while the prognosis for the other 71.2% would deteriorate.

Nearly 30% of our participants chose an inappropriate medium, namely isotonic saline. As in previous studies, saline was generally the (wrong) choice, and most respondents could not name any other options [3, 4, 11]. However, no specific culture medium was given as an option in these surveys. The results of these studies have to be evaluated very critically. In Germany, a recent publication pointed out the importance of correct and timely storage of an avulsed tooth. For this purpose, a special nutrient solution provided in special tooth rescue boxes was clearly suggested as the best storage medium [9]. It has the correct pH and contains electrolytes and keeps the cells of the periodontal ligament alive for up to 24 hours. Cold UHT milk would be the second best choice if a dental rescue box is not available [9, 16]. Sterile saline does not contain metabolically significant ions, does not provide glucose to the cells, and damages the tooth cells quite quickly, but is still much better than dry storage of the tooth [9, 16].

Although 71.9% of respondents knew what a dental rescue box was, only 30.7% reported that it was part of their ambulance's regular equipment. Adequate temporary storage of

Parameter		n	Knowledge score (Median)	p value
Gender	Male	501	11.2 (11.0)	0.464§
	Female	170	10.3 (12.0)	
Experience in emergency eervice	0 to 24 months 25 to 60 months > 60 months	651 133 164 343	10.50 (11) 10.08 (11) 10.64 (11) 10.60 (11)	0.041# 0.279+
Work experience	0 to 24 months 25 to 60 months > 60 months	641 125 166 358	10.49 (11) 10.02 (11) 10.53 (11) 10.64 (11)	0.065# 0.227+
Level of education	Completed	573	10.66 (12)	0.021§
	Not completed	74	9.32 (11)	
Type of training	Notfallsanitaeter/-Rettungsassistent*	479	10.49 (11)	0.071+
	Rettungssanitaeter**	163	10.69 (12)	
	Rettungsdiensthelfer***	14	8.58 (9)	
	Others	3	7.00 (5)	
Amount of exposure to TDI per month	0	462	10.6 (12)	0.557+
	1–10	158	10.4 (11.5)	
	11–20	7	11.3 (13)	
	> 20	9	9.3 (11)	
	No information given	30	9.9 (11)	
Dentist in family	No	640	10.46 (11)	0.357§
	Yes	19	11.2 (12)	

Table 6 Knowledge score for different parameters; abbreviations: n = number; TDI = traumatic dental injury; * "Notfallsanitäter/Rettungsassistent" = highest nonmedical qualification in the rescue service in Germany with 3 years/2 years of apprenticeship; ** "Rettungssanitäter" = emergency service personnel with 520 hours of training, work as a team partner of the "Notfallsanitäter/Rettungsassistent" or in ambulance transport; *** "Rettungsdiensthelfer" = 320 hours of training, as a partner of the "Rettungssanitäter" in ambulance transport or partner of the "Notfallsanitäter/Rettungsassistenten" in emergency service; # = linear regression, § = Student's t-test; + = ANOVA

avulsed permanent teeth is therefore more difficult, and inferior alternatives must be used unnecessarily. Adding a dental rescue box to the standard equipment of an ambulance could reduce complications mainly due to incorrect or delayed treatment of injured teeth and save costs with little effort [1, 17].

There were significant differences between the German federal states in the standard equipment of the ambulance with a dental rescue box. However, there was no difference in the score achieved on knowledge about the treatment of an avulsed tooth whether a tooth rescue box was part of the standard equipment or not. Possibly the reason is that while tooth rescue boxes are known, what they contain is not. When asked about the correct storage medium, there was no alternative answer option to the dental rescue box. Regardless of whether a dental rescue box is available or not, knowledge and skills in handling TDI may be deficient anyway. A recent study among German and international emergency physicians showed similarly poor results with a lack of knowledge about the intermediate storage of avulsed teeth [24, 25]. The training catalog for emergency physicians changed in 2017 with the new chapter "Oral and Maxillofacial Procedures" in the European Core Curriculum for Emergency Medicine. In addition to the AWMF polytrauma guideline and the AWMF guideline on dental trauma care, there is also information on dental primary care in a new book on clinical emergency medicine in Germany [5, 6, 12, 23]. The content of emergency paramedic training is regulated by the Emergency

Paramedic Act, although the content of the training is more in the hands of each state and training facility [10]. Curricular content for the care of TDI is not explicitly stated for any of the paramedic professions. Training content is not uniform across Germany. However, our results suggest that there is a knowledge deficit nationwide, which may indicate a gap in paramedic training content on this topic.

Previous studies have shown that partnership or family relationships with a dentist can have a positive impact on emergency physicians' knowledge and skills in managing TDI [15, 24]. In the present study, only 2.9% of the participants reported having a dentist in their family. However, there were no differences in knowledge scores due to this fact. Because of the small number of participants with a dentist in the family, no reliable statements can be made about the influence of the knowledge score in this regard.

Surveys of emergency physicians showed a significant influence of the number of dental trauma cases to be treated per month on the knowledge score [20, 22, 24]. In this study, approximately 70% reported not having witnessed dental trauma in their daily work, whereas other studies reported that over 60% of emergency paramedics had witnessed a TDI event during their service [19] and cases of oral and dental injuries did occur, but usually the only treatment was bleeding intervention [3]. It is possible that the focus of our participants has not previously been on dental trauma, and dental trauma has not been noticed or overlooked, which is consistent with the results of the survey on the performance of intraoral examinations. TDI are commonly associated with soft tissue injury and bleeding in the mouth or oral region in injured patients. However, this may also mask dental trauma or tooth loss, which are often overlooked by first responders or paramedics [15]. The level of knowledge in this study did not differ in terms of the number of dental trauma cases treated. However, this should be evaluated critically. It only confirms once again the great unmet need for training of paramedics as first responders in the management of TDI.

Paramedics typically do not receive the necessary theoretical and clinical training to assess and treat TDI. Adaptation of curricula with greater inclusion of dental aspects and first aid measures is necessary to ensure effective teaching and learning of proper management of TDI. The linkage between theory and clinical practice has been mentioned previously [25]. Since the participants primarily desired education/training on this topic via video or hands-on courses, the training could be structured as follows, following Yeng [25]:

- Theory on the FDI (Fédération Dentaire Internationale) dental chart, tooth anatomy, and differences between deciduous and permanent dentition, which would facilitate communication with continuing dentists.
- Likewise, theoretical basics on the types of dental trauma and their initial treatment. At least the use of the tooth rescue box should be made more familiar.
- The practical exercises should focus on the procedure of a structured intraoral examination with assessment of tooth and jaw injuries and on the replantation of an avulsed tooth.

5. Limitations

This study has some limitations that we need to point out. First, the number of 690 participants is small compared to all paramedics in Germany. The results presented here may not fully reflect the situation as it would have been reported by all paramedics. However, the participants came from all over Germany, and to our knowledge, this study evaluated by far the largest number of participants in such a study compared with all similar studies worldwide and can therefore be considered representative. Second, participation in this study was voluntary, so only those who were interested in the topic may have participated. Therefore, the results could be biased. Third, there was no control in filling out the questionnaires. Participants might have used books or the opinions of colleagues, friends, or relatives when answering the questions, which could have influenced the results. Another limitation is the lack of traceability of the number of questionnaires per ward. The results, for example on the proportion of dental rescue boxes carried in the ambulance, could be biased if several participants from the same station gave the same answer. Due to the anonymity of the questionnaires, it is not possible to identify the ward involved in the data collection. This should be taken into account when interpreting the results.

6. Conclusion

Paramedics currently have little knowledge and only a basic understanding of how to treat dental trauma. The initial treatment of dental trauma should become an integral part of paramedic training. The willingness to undergo such training is high among paramedics. But the structure and organization of the rescue service in Germany should also be revised. Dental rescue boxes must become standard equipment in ambulances in Germany. Paramedics could make an important contribution to dental trauma care.

Conflict of interest

The authors declare that there is no conflict of interest as defined by the guidelines of the International Committee of Medical Journal Editors.

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