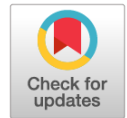


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A Pilot Study on Forensic Odontologists' Practices in the Registration and Analysis of Dog Bite Marks in Humans

Nikolaos Angelakopoulos¹, Nikita V. Polukhin², Sudheer B. Balla³, Galina V. Zolotenkova⁴¹ University of Bern, Bern, Switzerland;² Moscow University "Synergy", Moscow, Russia;³ La Trobe University, Bendigo, Australia;⁴ Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia

ABSTRACT

BACKGROUND: Dog bite marks and injuries on humans is a significant public health problem with a relatively major impact on economic productivity and quality of life.

AIM: To investigate current practices and perspectives of forensic odontologists regarding the analysis of dog bite marks, focusing on key aspects such as documentation protocols, canine examinations, DNA collection, and legal considerations across various jurisdictions.

METHODS: A survey was conducted among 22 forensic odontologists to obtain insights into their experiences and practices related to dog bite mark investigations. The respondents were asked about their approaches to documenting bite marks, examining suspect dogs, collecting biological evidence, and complying with legal requirements in different countries.

RESULTS: The sample population comprised an equal number of male and female participants, with a mean age of 47.3 ± 13.6 years. The majority (63.6%) were certified forensic odontologists, while 9.1% were pursuing advanced degrees. More than half (54.5%) had over 15 years of experience in the field. Approximately one-third (36.4%) reported having encountered dog bite cases. The majority of the respondents (95.4%) recognized the importance of photographing bite marks, with significant differences in opinion observed based on career stage ($p = 0.008$). Furthermore, respondents commonly utilized alginate, silicone, or other soft-body materials (50%) or digital photogrammetric scanning (36.4%) to obtain bite mark impressions. Despite the relatively limited adoption of photogrammetric scanning, 68.2% of forensic odontologists recommended its use. Additionally, 72.8% of respondents supported the necessity of collecting DNA and bacterial swabs. A substantial proportion (77.3%) acknowledged a lack of familiarity with specific dog profiling kits. Moreover, the majority (68.2%) endorsed the implementation of a standardized checklist to ensure accurate and consistent documentation of dog bite marks.

CONCLUSIONS: The survey findings highlight consensus on fundamental investigative steps including photographing bite marks and conducting canine examinations. However, the practices related to DNA collection and legal requirements across jurisdictions vary. Standardized protocols and further research are required to enhance the reliability and effectiveness of forensic analyses in this critical domain.

Keywords: dog bite marks; dog attack; injuries; online survey; checklist.

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Практическое применение методов судебной стоматологии для регистрации и оценки следов от укуса собаки на теле человека: пилотное исследование

N. Angelakopoulos¹, Н.В. Полухин², S.B. Balla³, Г.В. Золотенкова⁴¹ University of Bern, Берн, Швейцария;² Московский университет «Синергия», Москва, Россия;³ La Trobe University, Бендиго, Австралия;⁴ Первый Московский государственный медицинский университет имени И.М. Сеченова (Сеченовский Университет), Москва, Россия

АННОТАЦИЯ

Обоснование. Следы и повреждения от укуса собаки представляют серьёзную проблему для общественного здравоохранения, которая существенно влияет на экономику и ухудшает качество жизни населения.

Цель исследования. Изучить наиболее распространённые практики регистрации случаев укуса собаки и анализа соответствующих следов судебными стоматологами по всему миру.

Методы. В исследовании приняли участие 22 судебных стоматолога, которые ответили на вопросы, касающиеся их практического опыта в области оценки следов от укуса собаки. Респондентов попросили ответить на вопросы об их подходах к документированию следов от укуса собаки, осмотру животных, предположительно совершивших нападение, сбору вещественных доказательств биологического происхождения и соблюдению правовых норм в разных странах.

Результаты. Число участников мужского и женского пола в исследуемой выборке было равным. Средний возраст составил $47,3 \pm 13,6$ года. Большинство (63,6%) составляли дипломированные судебные стоматологи, ещё 9,1% проходили обучение для получения научной степени. Более половины участников (54,5%) имели стаж работы по специальности более 15 лет. Приблизительно 1/3 участников (36,4%) сталкивались со случаями укусов собак в своей практике. Большинство респондентов (95,4%) признали необходимость фотографической фиксации следов от укусов; при этом мнения статистически значимо различались в зависимости от этапа карьеры специалиста ($p=0,008$). Для изготовления слепков с места укуса участники, как правило, использовали альгинат, силикон и другие эластичные слепочные массы (50,0%), а также применяли методы цифровой фотограмметрии (36,4%). Несмотря на ограниченное распространение фотограмметрии, этот метод рекомендовали 68,2% судебных стоматологов. Кроме того, 72,8% участников отмечали важность получения образцов ДНК и образцов для проведения анализа на микрофлору. Преобладающее количество респондентов (77,3%) признались, что не знают о существовании специальных наборов для криминалистического профилирования собак с целью их идентификации по следам от укуса. Кроме того, большинство участников (68,2%) поддержали внедрение стандартизированного алгоритма для более точного и последовательного документирования следов от укуса собаки.

Заключение. Согласно результатам исследования, эксперты едины в оценке ключевых этапов криминалистических исследований, включая фотофиксацию следов от укусов и обследование собак. Тем не менее требования к получению образцов ДНК и правовые нормы могут различаться в зависимости от юрисдикции. Для повышения качества и надёжности судебно-медицинской экспертизы в этой важной области криминалистики необходимо разработать единые протоколы и провести дополнительные исследования.

Ключевые слова: следы от укуса собаки; нападение собаки; травмы; онлайн-исследование; алгоритм.

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法医牙科方法在记录和评估人体狗咬痕迹中的实际应用：一项初步研究

Nikolaos Angelakopoulos¹, Nikita V. Polukhin², Sudheer B. Balla³, Galina V. Zolotenkova⁴¹ University of Bern, Bern, Switzerland;² Moscow University "Synergy", Moscow, Russia;³ La Trobe University, Bendigo, Australia;⁴ Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia

摘要

论证：犬咬痕迹和损伤是一个严重的公共卫生问题，严重影响着经济和生活质量。

目的：探讨全球法医牙医最常见的犬咬病例记录和痕迹分析做法。

方法：本研究纳入了22名法医牙医，他们回答了关于其在犬咬痕迹评估领域的实践经验的问题。受访者被问及他们记录犬咬痕迹、检查疑似实施袭击的动物、收集生物证据以及遵守不同国家法律法规的方法。

结果：研究样本中的男性和女性参与者人数相等。平均年龄为47.3±13.6岁。大多数（63.6%）是持有执照的法医牙医，另有9.1%正在攻读学位。超过一半的参与者（54.5%）拥有超过15年的专科经验。约三分之一的参与者（36.4%）在实践中遇到过犬咬案件。大多数受访者（95.4%）认识到拍照记录咬痕的必要性；然而，不同职业阶段的专家对此的看法在统计学上存在显著差异（ $p=0.008$ ）。为了对咬痕部位进行取模，受访者通常使用藻酸盐、硅酮和其他弹性印模材料（50.0%），也应用数字摄影测量方法（36.4%）。尽管摄影测量技术的应用有限，但68.2%的法医牙医推荐使用这种方法。此外，72.8%的受访者指出了获取DNA样本和微生物群分析样本的重要性。绝大多数受访者（77.3%）承认，他们不知道存在用于对犬类进行法医分析以便通过咬痕识别其身份的专用工具包。此外，大多数受访者（68.2%）支持实施标准化算法，以便更准确、更一致地记录犬类咬痕。

结论：根据研究结果，专家们就法医调查的关键阶段达成了共识，包括对咬痕进行拍照记录和对犬只进行检查。然而，获取DNA样本的要求和法律法规可能因司法管辖区而异。为了提高这一重要法医学领域的法医检验质量和可靠性，有必要制定统一的规程并开展进一步的研究。

关键词：犬咬痕；犬袭击；伤害；在线研究；算法。

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BACKGROUND

Dog bites are a significant public health problem, with millions of incidents reported globally every year [1, 2]. The prevalence of dog bites varies across regions, influenced by factors such as population density, cultural practices, and the dynamics of human–dog interactions [3–6]. Understanding the extent of this issue is crucial for developing preventive measures and addressing the associated health implications. According to the World Health Organization, approximately 4.5 million people experience dog bites annually in the United States alone, underscoring its status as a widespread cause of injury worldwide [7–9]. Children face heightened vulnerability, with a greater possibility of sustaining bites to the face and head, leading to severe injuries and psychological consequences [10, 11]. Aside from the immediate physical impact and risk of infections, dog bites are a potential vector for zoonotic diseases, presenting additional challenges to public health.

Analysis of dog bite marks holds substantial forensic significance, considering its potential applications in legal investigations and solving criminal cases [12]. Comprehending the distinctive characteristics of dog bite marks is critical in assisting forensic professionals in multiple facets of their work [13–15]. It is crucial in situations wherein identifying the specific canine perpetrator is necessary for legal proceedings. Through the utilization of systematic analytical methods, forensic professionals can play a pivotal role in establishing a precise and unequivocal connection between the bite mark and responsible canine perpetrator.

Existing descriptive literature on the registration of dog bite marks on humans is scarce. Benevento et al. highlighted challenges in evaluating dog bite marks, reporting a lack of guidelines for identifying animal bites [16]. To overcome this limitation and enhance the comprehensiveness of reporting, leading to increased reproducibility, a registration checklist with an accompanying guide should be developed. However, studies on the current practices of forensic dental experts worldwide in the registration and analysis of dog bite marks on humans are limited.

AIM

To investigate the prevailing practices in the registration and analysis of dog bite marks in humans by forensic odontologists (FOs) globally.

METHODS

Study Design

This observational cross-sectional study included a comparative analysis of subgroups of FOs based on career stage and years of experience.

A self-applicable questionnaire was developed online using Microsoft Forms (<https://forms.office.com/Pages/>). It consisted of 36 questions, including 31 closed-ended and 5 open-ended questions requiring written answers, focused on the analysis of dog bite marks. The final question gathered free-form opinions from FOs and was therefore not subjected to quantitative analysis. The participants were instructed to provide responses to all the inquiries. A survey was distributed to FOs globally to gather data on their current practices and views concerning the documentation and examination of dog bite marks. The survey link was accessible for 21 days until its expiration on March 25, 2024. The participants were asked to allocate approximately 7–9 minutes to complete the questionnaire. The complete questionnaire is provided in Supplementary Material 1.

Participants

The study participants were FOs who were actively engaged in the field worldwide. Their expertise was crucial for providing insight into the practices associated with dog-bite mark analysis. All 111 invited participants were members of a closed WhatsApp group called the International Network for Forensic Odontology as of March 4, 2024.

Study outcome

The primary outcome of the study was based on the presence of consensus among FO members regarding practices in the registration and analysis of dog bite marks in humans. A particular focus was placed on identifying potential differences in opinions based on participants' career stages and years of experience.

Study groups

The sample was divided into subgroups to enable further comparisons. Participants were categorized by career stage as follows: FO Master's students, FO Ph.D. students, qualified FOs, and academics in FO. Years of experience in FO were also considered, with participants grouped into the following categories: 0–5 years, 5–10 years, 10–15 years, and 15 years or more.

Data Collection

The structured questionnaire was distributed to the qualified FOs. Data were collected through a structured questionnaire specifically designed for this study. The questionnaire covered aspects such as demographic information, registration protocols, analysis methods, challenges faced, and suggestions for improvement. Notably, the questionnaire was formulated based on literature references, particularly drawing insights from the study by Bernitz et al. in 2012 [12], which emphasized the individualization of dog bite marks and highlighted differences between dog and human bite marks. Thus, the present study adopted a methodologically informed approach to obtain comprehensive insights from FO experts.

Ethics Considerations

Ethics Approval

The outlined investigation protocol received approval from the Ethics Committee of Sechenov First Moscow State Medical University, Moscow, Russia (approval number: No 04-24; dated January 21, 2024).

Informed Consent

All participants were provided with detailed information about the research objectives and procedures prior to the study. Informed consent was obtained electronically before they proceeded with the questionnaire.

Confidentiality and Voluntary Participation

Data were collected anonymously and stored securely. The participants' personal information was protected, and any information that may reveal their identity was handled with the utmost confidentiality. Participation in this study was voluntary, and participants could withdraw at any stage without facing any consequences. The participants had a right to withdraw at any time without prejudice and without providing a reason.

Data Analysis

Descriptive statistics were used to provide a comprehensive overview of current practices among forensic dental experts regarding dog-bite mark analysis. Considering the descriptive nature of the research question, 95% confidence intervals were used as the primary inferential statistical technique to measure the uncertainty associated with the estimates derived from the sample. Specifically, Jeffrey's method was applied to calculate the confidence intervals for proportions. This method is robust and conservative, making it particularly suitable for small sample sizes [17]. This approach was

selected for its ability to provide a more precise estimation of the true population proportion, even with limited observations. Pearson's χ^2 test, followed by pairwise comparisons with Bonferroni correction, was employed to explore potential differences between groups based on the respondents' experience or career stage. Statistical analysis was conducted using IBM SPSS Statistics 26.0.

RESULTS

No significant differences in the distribution of answers between participant groups, based on either career stage or years of experience, were found, except for one question. Thus, the results are presented descriptively, reflecting the collective opinion of the expert community without unnecessary or insignificant comparative data. The only significant difference is highlighted in the corresponding section.

Survey Demographics and Participant Characteristics

The overall response rate after two reminders was 19.81%, indicating that 22 FOs completed the survey. Of the 22 participants, 11 were males and 11 were females. The participants were aged 26–70 years (mean age: 47.3 ± 13.6 years). The respondents were from the United States, Brazil, Australia, Switzerland, New Zealand, the United Kingdom, Malaysia, India, Sweden, Saudi Arabia, Belgium, Japan, Italy, and Finland.

Fourteen participants (63.6%) were identified as qualified FOs, either working part-time or full-time. Moreover, 5 participants (22.7%) were academic professionals in the field of FO. One respondent (4.5%) was pursuing a master's degree in FO, and 2 respondents (9.1%) were pursuing PhD degrees in FO. Furthermore, 12 respondents (54.5%) had over 15 years of experience in forensic odontology. Two respondents (9.1%) had experience ranging between 10 and 15 years,

Table 1. Distribution of survey participants ($n = 22$) across demographics and experiences

Category	<i>n</i>	%	95% CI
<i>Sex</i>			
Male	11	50.0	30.2–69.8
Female	11	50.0	30.2–69.8
<i>Occupation or career stage</i>			
Academic in Forensic Odontology	5	22.7	9.2–42.9
Forensic Odontology Master Student	1	4.5	0.5–19.3
Forensic Odontology PhD Student	2	9.1	1.9–26.1
Qualified Forensic Odontologist (working part-time/full-time)	14	63.6	42.9–81.1
<i>Years of experience</i>			
0–5 years	4	18.2	6.5–37.6
10–15 years	2	9.1	1.9–26.1
5–10 years	4	18.2	6.5–37.6
Over 15 years	12	54.5	34.3–73.7

and 4 (18.2%) had experience spanning 5–10 years. Similarly, 4 respondents (18.2%) reported having <5 years of experience in FO (Table 1).

FOs' Encounters With Dog Bite Mark Cases

Eight respondents (36.4% [95% CI: 18.9–57.1%]) had previously encountered cases of dog bite marks.

Of the 8 respondents who had dealt with cases involving dog bite marks, 4 respondents (50.0% [95% CI: 19.9%–80.1%]) reported encountering one to two cases of dog bites annually. Four respondents with previous experience with dog bite marks (50.0% [95% CI: 19.9%–80.1%]) reported that they had less than one case per year. Six of them (75.0% [95% CI: 18.9%–57.1%]) stated that they were very likely to take photographs of the bite marks, whereas one respondent (12.5% [95% CI: 1.4%–45.4%]) it was “somewhat likely” to do so. However, one respondent (12.5% [95% CI: 1.4%–45.4%]) indicated that it was “somewhat unlikely” to take a photograph of the bite marks.

FOs' Procedures in Dog-Bite Mark Analysis

As presented in Table 2, all eight FOs who had previously encountered dog bite marks measured the inter-canine distance and took dental impressions of suspected canines. Moreover, 4 of them (50.0% [95% CI: 19.9%–80.1%]) utilized alginate material to record the dentition of the dog, 2 (25.0% [95% CI: 5.6%–59.2%]) employed a digital impression system, and the remaining 2 (25.0% [95% CI: 5.6%–59.2%]) used both. Nevertheless, 3 of those FOs (37.5% [95% CI: 11.9%–70.5%]) included a dog dental chart in their reports.

The survey results indicated a high degree of consensus among the surveyed FOs regarding the importance of photographing dog bite marks. Specifically, 3 respondents (13.6% [95% CI: 4.0%–32.1%]) expressed agreement, while 18 respondents (81.8% [95% CI: 62.4%–93.5%])

expressed strong agreement. One respondent identified with an academic context, representing 4.5% (95% CI: 0.5%–19.3%) of the surveyed group, strongly disagreed to this viewpoint (Fig. 1). It should be noted that opinions on the advisability of photographic recording differed statistically significantly depending on the stage of the specialist's career ($p = 0.008$). It is noteworthy that strong agreement was expressed by 4 out of 5 academic professionals in forensic odontology (80.0% [95% CI: 37.1%–97.7%]). All the PhD students (2) expressed agreement, and a student pursuing a master's in FO indicated strong agreement to photographing dog bite marks. Furthermore, 13 of the 14 qualified FOs (92.9% [95% CI: 71.2%–99.2%]) indicated a strong agreement with the importance of photographing dog bite marks, whereas the remaining one (7.1% [95% CI: 0.8%–28.8%]) indicated a simple agreement.

The majority of respondents revealed that they either agreed or strongly agreed to the importance of DNA collection and bacterial swabs from puncture wounds in cases of dog bite marks. The number of respondents who expressed either agreement or strong agreement was identical, totaling 5 (36.4% [95% CI: 18.9%–57.1%]) for each response to both questions. One respondent, identified as an academic in forensic odontology (4.5% [95% CI: 0.5%–19.3%]), disagreed with the proposition that the collection of DNA swabs is of importance.

Regarding the question of whether impressions should be consistently taken from puncture wounds in cases of dog bites, 6 respondents (27.3% [95% CI: 12.3%–47.8%]) agreed and 9 respondents (40.9% [95% CI: 22.5%–61.5%]) strongly agreed, while 3 respondents (13.6% [95% CI: 4.0%–32.1%]) disagreed and 2 (9.1% [95% CI: 1.9%–26.1%]) strongly disagreed with the importance of this action.

With regard to the methodology to procure bite mark impressions, among the total FOs, 11 (50.0% [95% CI:

Table 2. Distribution of responses from forensic odontologists with experience in dealing with dog bite marks ($n = 8$) regarding reporting and procedures

Answers	<i>n</i>	%	95% CI
<i>Do you always measure the inter-canine distance of the suspected dog(s)?</i>			
Yes	8	100.0	73.8–100.0
No	0	0.0	0.0–26.2
<i>Do you take dental impressions of the suspected dog(s) dentition?</i>			
Yes	8	100.0	73.8–100.0
No	0	0.0	0.0–26.2
<i>How do you record the dog's dentition?</i>			
A digital impression system	2	25.0	5.6–59.2
Alginate impression material	4	50.0	19.9–80.1
Both	2	25.0	5.6–59.2
<i>Do you include a dog dental chart on your reports?</i>			
Yes	3	37.5	11.9–70.5
No	5	62.5	29.5–88.1

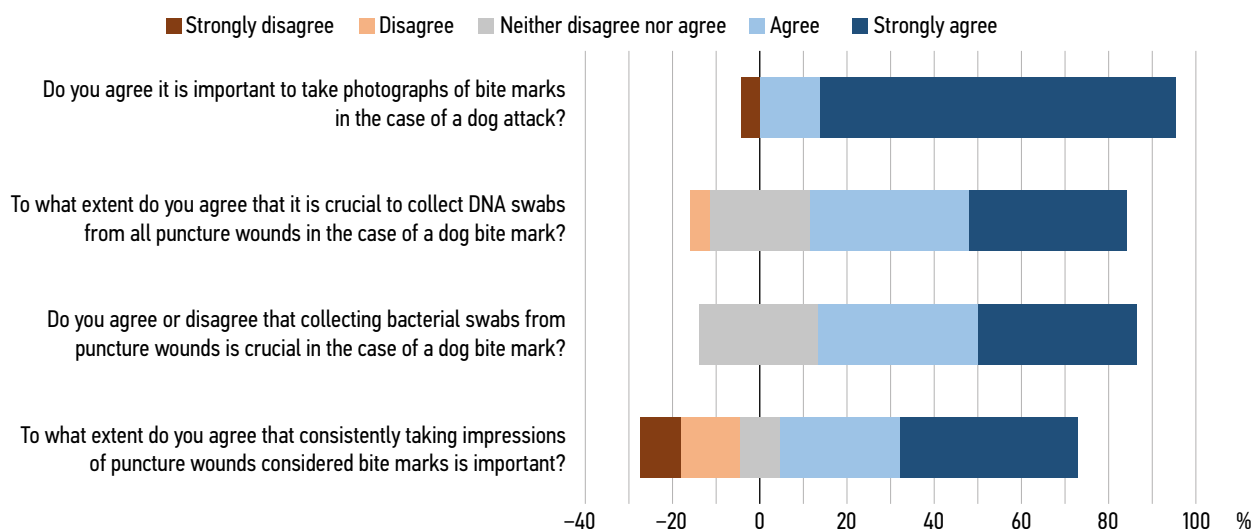


Fig. 1. Likert-scale responses to questions about procedures during dog bite mark expertise among all FOs ($n = 22$).

30.2%, 69.8%) utilized alginate, silicone, or other soft body materials. Furthermore, 36.4% (95% CI: 18.9%–57.1%) used digital photogrammetric scanning for the same purpose. A combination of these two techniques was used by 2 surveyed FOs (9.1% [95% CI: 1.9%–26.1%]). Additionally, 2 participants (9.1% [95% CI: 1.9%–26.1%]) did not provide any specific method, whereas one participant (4.5% [95% CI: 0.5%–19.3%]) recommended not taking impressions because of the possibility of tissue and mark distortion.

Despite the lower proportion of respondents who adopted the method, 15 respondents (68.2% [95% CI: 47.4%–84.5%]) recommended using photogrammetric techniques for registering puncture wounds, and one respondent (4.5% [95% CI: 0.5%–19.3%]) did not suggest its adoption. Six remaining respondents (27.3% [95% CI: 12.3%–47.8%]) expressed uncertainty about use of the method. Regarding the existence of specific profiling kits for the individualization of dogs, 17 participants (77.3% [95% CI: 57.1%–90.8%]) indicated that they were unaware of their existence, 4 participants (18.2% [95% CI: 6.5%–37.6%]) revealed that they were aware of their existence, and one (4.5% [95% CI: 0.5%–19.3%]) expressed uncertainty in this matter. Additionally, regarding the follow-up photographs, 11 FOs (50.0% [95% CI: 30.2%–69.8%]) strongly agreed and 6 FOs (27.3% [95% CI: 12.3%–47.8%]) agreed to their importance, whereas 3 FOs (13.6% [95% CI: 4.0%–32.1%]) disagreed with their importance.

Legality and Protocols Regarding Excising Puncture Wounds in FO Practice

Four FOs (18.2% [95% CI: 6.5%–37.6%]) reported that excising puncture wounds is legally allowed in their countries. These respondents were from the United States ($n = 1$), New Zealand ($n = 1$), and Brazil ($n = 2$). In contrast, 10 FOs (45.5% [95% CI: 26.3%–65.7%]) mentioned that excising puncture wounds is prohibited in their respective

countries. Eight FOs (36.4% [95% CI: 18.9%–57.1%]) expressed uncertainty regarding the permissibility of excising puncture wounds in their countries (Table 3).

Eight FOs (36.4% [95% CI: 18.9%–57.1%]) mentioned the existence of a veterinary state authority in their countries that should be informed about puncture wounds that indicate bite marks.

Among these eight, 3 FOs (37.5% [95% CI: 11.9%–70.5%]) specified needing permission from the veterinary authority to conduct investigations. The other FOs either stated the absence of such an authority in their country or were unsure about its existence.

FO Investigations: Focus on Dog-Related Practices

Fig. 2 shows that 6 respondents (27.3% [95% CI: 12.3%–47.8%]) agreed and 11 respondents (50.0%; 95% CI: 30.2%, 69.8%) strongly agreed with the inclusion of canine examination information in their reports. Only one respondent (4.5% [95% CI: 0.5%–19.3%]) strongly disagreed. A slightly fewer respondents, specifically 6 (27.3% [95% CI: 12.3%–47.8%]) agreed and 10 (45.5% [95% CI: 26.3%–65.7%]) strongly agreed that the presence of a forensic odontologist during documentation of the dog's dentition and specific examination is critical. Six respondents (27.3% [95% CI: 12.3%–47.8%]) neither agreed nor disagreed, whereas no respondents disagreed or strongly disagreed.

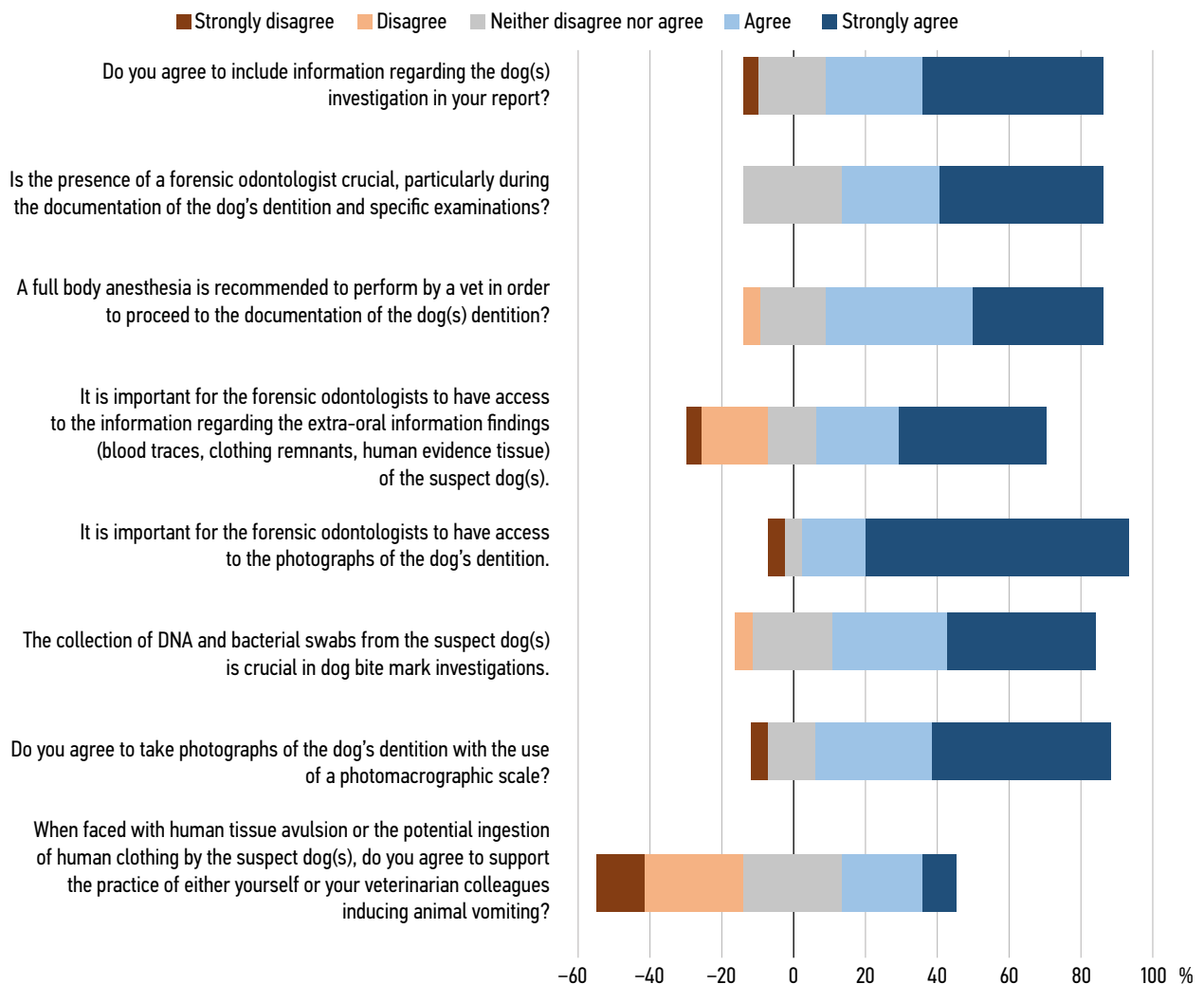
Moreover, 9 respondents (40.9% [95% CI: 22.5%–61.5%]) agreed and 8 (36.4% [95% CI: 18.9%–57.1%]) strongly agreed to the recommendation to use general anesthesia to document the dog's dentition. One respondent (4.5% [95% CI: 0.5%–19.3%]) disagreed to this recommendation.

Concerning the need for FOs to have access to information regarding extra-oral findings (e.g., blood traces, clothing remnants, and human tissue) of the suspect, 5 respondents (22.7% [95% CI: 9.2%–42.9%]) indicated agreement

Table 3. Distribution of responses from survey participants ($n = 22$) regarding the legal authorization for the investigation of dog bite marks

Answers	n	%	95% CI
<i>Is it allowed by law in your country to excise puncture wounds thought to be bite marks?</i>			
Yes	4	18.2	6.5–37.6
No	10	45.5	26.3–65.7
Don't know	8	36.4	18.9–57.1
<i>Is there any relevant veterinary state authority in your country that needs to be aware of any puncture wounds (probable bite mark) incident?</i>			
Yes	8	36.4	18.9–57.1
No	7	31.8	15.5–52.6
Don't know	7	31.8	15.5–52.6
<i>If yes, do you require their permission in order to proceed with any investigation?*</i>			
Yes	3	37.5	11.9–70.5
No	5	62.5	29.5–88.1

Note. * Only among those who reported a presence of veterinary state authority.

**Fig. 2.** Likert-scale responses to questions about information and procedures during dog bite mark expertise.

and 9 respondents (40.9% [95% CI: 22.5%–61.5%]) indicated strong agreement, whereas 4 respondents (18.2% [95% CI: 6.5%–37.6%]) indicated disagreement and 1 (4.5% [95% CI: 0.5%–19.3%]) indicated strong disagreement to this necessity.

Four respondents (18.2% [95% CI: 6.5%–37.6%]) agreed and 16 respondents (72.7% [95% CI: 52.2%–87.7%]) strongly agreed to the importance of FOs having access to photographs of the dog's dentition. One FO (4.5% [95% CI: 0.5%–19.3%])

expressed disagreement to this statement. Furthermore, 7 FOs agreed (31.8% [95% CI: 15.5%–52.6%]) and 9 (40.9% [95% CI: 22.5%–61.5%]) strongly agreed to the critical importance of collecting DNA and bacterial swabs from suspect dogs. Nevertheless, one FO (4.5% [95% CI: 0.5%–19.3%]) disagreed to this statement. Seven FOs (31.8% [95% CI: 15.5%–52.6%]) agreed and 11 FOs (50.0% [95% CI: 30.2%–69.8%]) strongly agreed that photographs of the dog's dentition should be taken using a photomacrographic scale. One respondent (4.5% [95% CI: 0.5%–19.3%]) indicated that such a procedure is unnecessary, expressing a strong disagreement.

In cases of human tissue avulsion or the potential ingestion of human clothing by the suspect dog, only 5 FOs (22.7% [95% CI: 9.2%–42.9%]) expressed agreement and 2 FOs (9.1% [95% CI: 1.9%–26.1%]) expressed strong agreement to the need to induce animal vomiting. In contrast, 6 respondents (27.3% [95% CI: 12.3%–47.8%]) indicated disagreement and 3 respondents (13.6% [95% CI: 4.0%–32.1%]) expressed strong disagreement with the need for the proposed course of action.

Additionally, 10 respondents (45.5% [95% CI: 26.3%–65.7%]) revealed that it is common practice in their countries to quarantine the suspect animal in the event of human tissue avulsion. Three respondents (13.6% [95% CI: 4.0%–32.1%]) stated that this is not a common practice in their countries, whereas the remaining 9 respondents (40.9% [95% CI: 22.5%–61.5%]) expressed uncertainty about the matter. Among the FOs who indicated the presence of the practice, 3 (30.0% [95% CI: 9.3%–60.6%]) reported the analysis of the feces for human body tissues, foreign bodies, and victims' clothing.

Call for Standardized Checklist: Dog-Bite Mark Registration

Fifteen out of 22 surveyed FOs (68.2% [95% CI: 47.4%–84.5%]) indicated a need for a checklist for the registration of dog bite marks on humans. Five respondents (22.7% [95% CI: 9.2%–42.9%]) expressed uncertainty about this necessity, and only 2 (9.1% [95% CI: 1.9%–26.1%]) indicated the lack thereof.

DISCUSSION

The study surveyed 22 FOs from diverse geographic regions and career stages, providing insights into their practices and perspectives on the analysis of dog bite marks. The majority of respondents emphasized the importance of photographing bite marks, collecting DNA and bacterial swabs, and utilizing alginate or digital scanning for bite mark impressions. However, notable variability in methodologies was observed. The findings further highlighted a strong consensus on the necessity of a standardized checklist for the documentation of dog bite marks, underscoring the critical importance of consistency in forensic practice. Dog bite incidents notably increased worldwide [6, 7, 9].

However, only a minority of the surveyed FOs (36.4%) had prior experience with dog-bite mark cases. This shows that despite the rising trend in dog bite incidents, FOs may not consistently consulted for these cases, or such cases may be inadequately reported or documented. Conversely, analyzing dog bite marks is a multifaceted process requiring expertise in FO and veterinary medicine [9].

Analysis of dog bite marks is significantly critical in forensic investigations, offering valuable insights for legal proceedings [18]. It establishes an association between observed injuries and specific incidents, particularly crucial in cases wherein dog bites are contested [12, 15]. Forensic evidence is beneficial for reconstructing the sequence of events. Experts can differentiate between injuries caused by dog bites and those caused by other means, such as human assaults or accidents [12]. This differentiation is essential for accurately understanding the situation and assigning accountability. In 2012, Bernitz et al. [12] introduced a comprehensive protocol for dog-bite mark analysis, recommending procedures to follow at the forensic scene and during the examination of the involved dog(s). This protocol combines elements from two established bite mark collection protocols [19, 20] used in crime scene investigations, with necessary modifications. It outlines crucial steps for all cases involving dog bite marks, encompassing investigation procedures for both the victim and responsible dog(s).

Bernitz et al. [12] suggested photographing all puncture wounds that may be bite or claw marks during victim investigation. Our survey findings showed a strong consensus among the majority of FOs regarding the importance of photographing dog bite marks. Moreover, the participating FOs indicated the significance of capturing follow-up photographs in nonfatal incidents.

Identifying the dog responsible for a bite is crucial in dog-bite mark analysis [12]. Thoroughly examining bite marks and, in some instances, conducting DNA analysis on saliva or other biological residues found at the scene help forensic experts determine the possible breed or individual dog involved [12, 15]. Bernitz et al. [12] recommended obtaining DNA and bacterial swabs from all puncture wounds and utilizing specialized profiling kits for dog identification. The participating FOs' responses to this revealed significant variability in the practice of collecting such swabs. Most respondents agreed on the importance of obtaining DNA and bacterial swabs, whereas only a few were aware of the availability of specific profiling kits for dog individualization. The lack of awareness among FOs regarding specialized profiling kits for dog individualization can be attributed to various factors. First, FOs primarily focus on human identification and may not have received formal training or education in veterinary forensic science, which encompasses animal-related investigations. This specialization gap could result in limited exposure to tools and techniques specifically used for animal-related forensic analysis. Additionally, veterinary forensics, including the use

of profiling kits for dog identification, may be relatively niche and not widely integrated into mainstream forensic practices. Thus, FOs may not actively seek information or updates related to advancements in this specific area. Furthermore, limited interdisciplinary collaboration between forensic and veterinary professionals may contribute to the lack of knowledge exchange of emerging technologies in animal forensics.

Survey findings regarding the practice of taking impressions of puncture wounds reveal a mixed perspective among respondents. While a majority (68.2%) expressed agreement or strong agreement to the importance of taking impressions, a notable proportion (22.7%) disagreed or strongly disagreed to this action. The techniques employed for obtaining bite mark impressions varied among respondents, with approximately 50.0% utilizing alginate, silicone, or other soft body materials and 36.4% using photogrammetric scanning methods [21]. Interestingly, one forensic odontologist raised concerns about potential tissue and mark distortion, advising against taking impressions. Despite the relatively lower adoption rate of photogrammetric scanning, 68.2% of respondents recommended its use for documenting puncture wounds. These results reveal the diversity in approaches and opinions within the forensic odontology community regarding the optimal methods for capturing and documenting bite mark impressions.

Our findings align with the guidelines outlined in the Bernitz protocol [12], emphasizing that excision of puncture wounds suspected to be bite marks should be reserved for extraordinary cases requiring additional forensic evidence, often influenced by legal statutes across different jurisdictions. Surprisingly, only a few FOs indicated legal permission for excision in their countries, representing nations such as the United States, New Zealand, and Brazil. Conversely, several FOs highlighted that such an excision is not sanctioned in their countries. The practice of extracting tissue bearing the bite mark from deceased victims is widespread in the United States, but is impractical for bite mark evidence collection in Australia [22]. A remarkable 87.5% of American Board of Forensic Odontology diplomates reportedly undertake excision of the injured site [23]. However, 36% of our survey participants seem unaware of the legislative nuances surrounding this matter in their respective employment regions.

Prior to starting any investigation, FOs should ensure compliance with all relevant legal prerequisites concerning the examination of the victim and any implicated dogs [12]. Adhering to these legal stipulations, FOs should inform veterinary state authorities about incidents involving puncture wounds potentially indicative of bite marks, if mandated by law. Moreover, some of the surveyed FOs acknowledged the existence of a veterinary state authority in their respective countries that mandates notification of such incidents. In certain countries, securing permission from the veterinary authority may be warranted to proceed

with investigations pertaining to animal-related injuries. In Switzerland, as outlined in the Federal Act on Animal Protection (RS 455.1) [24], veterinarians, doctors, kennel or shelter managers, dog trainers, and customs authorities are required to report any incident wherein a dog causes injury to a human to their respective cantonal veterinary office. Additionally, under Cantonal Laws on Animal Protection, all dog owners should report to the cantonal veterinary office if their dog has attacked a person. This ensures that authorities are informed of incidents involving dog-related injuries or aggression for appropriate follow-up and enforcement of animal protection measures. Among respondents aware of this authority, 37.5% mentioned requiring permission from the veterinary authority to conduct such investigations. Others either noted the absence of such an authority in their country or expressed uncertainty regarding its presence.

Our survey yielded valuable insights into the FOs' perspectives and practices regarding dog-bite mark investigations. The majority of respondents (77.3%) strongly agreed on the importance of including canine examination, highlighting their significance in documenting detailed dental findings from suspect dogs. This is consistent with the recommendations of Bernitz et al. [12], wherein canine examination is deemed crucial in bite mark analysis. Additionally, the majority of FOs emphasized their role in documenting the dog's dentition and conducting specific examinations. This underscores the significance of expert involvement in assessing and interpreting canine characteristics. Furthermore, the recommendation to employ general anesthesia for documenting the dog's dentition received strong endorsement, with 77.3% of respondents expressing agreement. General anesthesia is favored for its ability to enable a thorough and precise examination, minimizing the potential for injury or stress to the animal while ensuring meticulous forensic documentation.

The importance of accessing information related to extra-oral findings, such as blood traces, clothing remnants, and human tissue, was emphasized by most of the FOs. This highlights the holistic approach necessary in bite mark investigations, wherein context and additional evidence play crucial roles in analysis and interpretation. The significance of photographs depicting the dog's dentition was indicated, with 90.9% of respondents agreeing to their importance. Visual documentation facilitates pattern recognition and comparison, serving as valuable forensic evidence. Furthermore, 72.7% of the respondents acknowledged the importance of collecting DNA and bacterial swabs from suspect dogs. This practice can yield genetic and microbiological evidence that complements bite mark analysis, enhancing the comprehensiveness of forensic investigations.

Notably, every respondent with previous involvement in bite mark cases took essential steps such as measuring inter-canine distances and capturing dental impressions of suspected canines, highlighting foundational aspects of canine identification and bite mark analysis. Among these

respondents, 50% utilized alginate material for recording dog dentition, whereas others employed digital impression systems or a combination of both methods. However, a few FOs incorporated a dog dental chart in their reports, showing potential variability in reporting practices across practitioners. Additionally, our survey underscored the perceived importance of a standardized checklist for documenting dog bite marks on humans, with most of the FOs expressing a need for such a tool. This emphasizes that consistent protocols and documentation standards in forensic odontology are warranted to enhance the precision and trustworthiness of bite mark analyses.

Limitations

Despite the fact that the global number of FO is unknown owing to the lack of official demographic data, the relatively small sample size of 22 participants is a limitation of the present pilot study, potentially affecting the generalizability, reliability, and validity of the findings. Several strategies were employed to address these concerns, including a pilot study design, convenience sampling, data quality control, and statistical adjustments. Considering the modest sample size, the application of Pearson's chi-square test was limited, and the results should be carefully interpreted. However, the analysis provided valuable insights into potential differences between groups, and the Bonferroni correction helped control for inflated type I error rates caused by multiple comparisons. Future studies should replicate this research with a larger sample of FOs to address these limitations.

Implications and Future Directions

These survey findings provide valuable insights for forensic odontology practices in dog-bite mark analysis. They highlight consensus and divergence among practitioners, underscoring the need for standardized protocols and further research to guide best practices in this field. Future studies should explore the reasons behind varying opinions and assess the impact of different investigative approaches on bite mark analysis outcomes. In the future, we aim to conduct qualitative evaluations of the FOs who are experienced in dog-bite mark analysis and investigate their experiences, the challenges they face, and the need to improve the quality of dog-bite mark investigations.

Arguments Explaining Nonresponse

The response rate of 22 of 111 distributed surveys (approximately 19.8%) was lower than anticipated, potentially influenced by several factors. The survey distribution via WhatsApp® may have limited visibility beyond the immediate network of the survey initiator, reducing exposure to a broader audience. Additionally, the specialized topic of dog bite marks and forensic odontology could have deterred participation from individuals who felt uncomfortable or lacked expertise in this area. Time constraints due to professional

commitments, research projects, or personal obligations may have restricted participant availability during the survey period. Some recipients may have been unaware of the survey or perceived the topic as irrelevant to their expertise or interests within forensic odontology. Additionally, survey fatigue, caused by frequent survey requests in the field, may have reduced willingness to participate. The informal nature of WhatsApp® communication and concerns about privacy and confidentiality associated with personal messaging platforms may have further contributed to respondent hesitation or nonparticipation. Finally, distractions and message volume on WhatsApp® could have led respondents to overlook or delay responding to the survey amidst competing messages and activities on the platform. These factors show the challenges associated with using WhatsApp® as a distribution method for specialized surveys and underscore the importance of optimizing survey design and distribution strategies to improve participant engagement and response rates in future research endeavors.

CONCLUSION

This study presents significant insights into the current practices and perspectives of forensic odontologists in the investigation of dog bite marks. The findings reveal the importance of standardized protocols and comprehensive documentation in bite mark analysis. While there is broad agreement on fundamental investigative steps such as photographing bite marks and canine examinations, variations in practices related to DNA collection and legal requirements across different jurisdictions are noted. These emphasize the need for continued research and the development of standardized guidelines to enhance the reliability and effectiveness of forensic analyses in this critical domain. Future collaboration between FOs and veterinary forensic professionals is crucial to advance knowledge and practices in animal-related forensic investigations.

ADDITIONAL INFORMATION



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AUTHORS' INFO

* **Nikolaos Angelakopoulos**, DSS, MSc(FO);
address: 7 Freiburgstrasse st, Bern, Switzerland, 3010;
ORCID: 0000-0001-8511-4645;
e-mail: nikolaos.angelakopoulos@unibe.ch

Nikita V. Polukhin, MD, Cand. Sci. (Medicine);
ORCID: 0000-0002-9540-5793;
eLibrary SPIN: 8047-9245;
e-mail: nikitasketch@gmail.com

Sudheer B. Balla, MFOdont;
ORCID: 0000-0003-0977-3889;
e-mail: forensics.sudheer@gmail.com

Galina V. Zolotenkova, MD, Dr. Sci. (Medicine), Professor;
ORCID: 0000-0003-1764-2213;
eLibrary SPIN: 1685-1802;
e-mail: zolotenkova.galina@bk.ru

ОБ АВТОРАХ

* **Angelakopoulos Nikolaos**;
адрес: Швейцария, 3010, Берн, ул. Фрайбургштрассе, д. 7;
ORCID: 0000-0001-8511-4645;
e-mail: nikolaos.angelakopoulos@unibe.ch

Полухин Никита Валерьевич, канд. мед. наук;
ORCID: 0000-0002-9540-5793;
eLibrary SPIN: 8047-9245;
e-mail: nikitasketch@gmail.com

Balla Sudheer Babu;
ORCID: 0000-0003-0977-3889;
e-mail: forensics.sudheer@gmail.com

Золотенкова Галина Вячеславовна, д-р мед. наук, профессор;
ORCID: 0000-0003-1764-2213;
eLibrary SPIN: 1685-1802;
e-mail: zolotenkova.galina@bk.ru

* Corresponding author / Автор, ответственный за переписку