Bitemark pathobiology

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Abstract. Forensic odontology is one branch of forensic science that plays a role in the process of individual identification. Cases that often require a review from the perspective of forensic odontology are bitemark cases. Bitemark cases are often found in acts of violence or sexual violence, both to the victim and to the suspect. However, today bitemark analysis often experiences problems due to the many distortions that can occur. For this reason, it is important to know the pathobiology of bitemark in the healing process because by doing this analysis, it can be estimated when the bitemark is carried out, so that it can lead to an adequate identification process. This manuscript is a preliminary text for research on the pathobiology of post-bite tissue carried out.

1. Introduction

Forensic odontology as a branch of forensic science, has an important role in identifying a person. Forensic odontology identifies a person through a series of dental examinations. In crime and immorality, analysis in the field of forensic odontology that is often used to identify a person is a bitemark analysis/bite marks [1]. Bitemark is a patterned wound caused by a tooth, which has variations in shape, size and surface. Bitemark is often found on human skin, but not infrequently, it can also be found on other objects such as apples or gum. Bite marks visible on these objects are often clearer and more pronounced than those found on human skin [2,3].

Bitemark examination is often found because in acts of violence, it is not uncommon for a suspect to bite one part of the victim's body, or the victim bit into the suspect for self-protection. Bite marks that appear on the body of the victim or suspect can be used as a forensic odontologist to identify.[4-6] Biomechanics in the formation of these bite marks is quite complicated, namely depending on the teeth of the offender, the position of the offender's tongue when biting, occlusion of the perpetrator's jaw, bite intensity, victim's healing reaction, and type of organ and tissue at the bite site.

The rationale for bitemark examination is to compare information on existing teeth in the victim, and compare with suspects.¹ Generally, the process of identifying bitemarks is done by comparing the results of photo interpretation of bite marks on victims compared with suspect tooth models. The analysis carried out is the measurement of the teeth, shape, and position of each tooth. From the results of the analysis, it can then be concluded whether the bite marks really belonged to the suspect or not [7].

However, today bitemark analysis is increasingly inviting controversy.[8,9] This cannot be separated from bitemarks which often experience distortion due to the healing process or due to changes in body
position.[10] In addition, before concluding that the wound is a bite mark caused by the suspect, a number of preliminary examinations must be carried out first; such as whether the bite mark is indeed a bitemark, or actually just an ordinary injury or even caused by himself (self inflicting), then if the wound is a bite, whether the bite marks are caused by humans, not animals, and so forth. In addition, bite marks in twins or people with orthodontic treatment also have their own difficulty levels. If you find a case like this, the 3D analysis must be done to be able to distinguish the perpetrators.[1] With the large number of examinations that need to be passed, and often sampling in bitemark cases tends to be inadequate, then a number of organizations report a lot of false positives and false negatives in basing cases. its assessment from the analysis of bite marks [4].

Misidentification of bitemark is also often caused by the healing process that occurs in living victims. This can occur because the tissue that is damaged by the bite will heal over time.10 Thus, if the bitemark examination is not carried out as soon as possible, then the possibility of bias will be higher because the analysis obtained from the bite marks is increasingly ineffective. For this reason, it is necessary to understand the stages of injury and healing in the case of bitemark so that forensic odontologists can conduct an adequate identification analysis. At a minimum, with bitemark analysis using a pathobiological review, it can be seen when the bitemark occurred so that it can lead to a good identification process.

2. Results and discussion

2.1. Used bite analysis of human skin

Analysis of the bite marks is needed to look for the presence of Langer lines, i.e. changes that occur in the skin after trauma. The development of the analysis of bite marks today actually leads to photography techniques. Even though there is an important part that is forgotten, namely a question about whether human skin is a good medium for recording bite marks. Because if it turns out the skin is not a good bite recording media, then the best photography produced will not be effective for identification [4].

Changes in the skin that occur in cases of bitemark vary, namely in the form of hemorrhage or small bleeding; abrasion that does not damage skin tissue; contusions ruptured blood vessels, usually accompanied by bruises; laceration, a kind of stab wound to the skin; incisions, punctures on the skin in a neat shape according to the edges of the teeth; and avulsion, skin loss or loss [11].

The identification of bite marks is due to the uniqueness of human teeth and skin as an accurate recording or printing material. The composition of the teeth is unique and will differ from one person to another so that it can be used as a medium for identification [12]. While the skin is a medium that is considered to be good enough to record information on the former bite for a certain period. So that methods to move the bite marks from the victim to another media so that it is easier to do the examination developed. Because the perpetrator's dental information will be recorded in the dermis and/or epidermis of the victim [6]. However, there are many doubts about the developing bitemark paradigm, such as the lack of evidence regarding bite marks that can be collected, the high error rate resulting from bitemark analysis, and the lack of validity and bitemark analysis reliability [5,6].

The subject of the quality of the skin as a bite mark recorder is a distortion in the postural movements of the skin, which makes the analysis of the bite marks biased and ineffective. In a sense, if the position at the time of the bite and analysis of the bite posture of the victim's body are different, then there might be a bias that can confuse the results of the analysis [6]. This possibility has indeed been realized by forensic odontologists, but an important assessment is the extent of distortion. This can confuse the results of the analysis. For example, a study revealed that the central incisors contained in bite marks rotated 20 degrees. In fact, the original teeth only rotated by 5 degrees. This should be noted by all forensic odontologists who conduct the analysis so as not to be mistaken in their identification [4].

Other studies suggest that distortion can be predicted, depending on where the network is bitten and the victim's position when bitten. Biological factors such as muscle mass and fat content in a tissue actually affect the shape of the bite marks, but due to the non-linear relationship, these biological factors
become difficult to predict. Often, in the same organ and the same bite force, the shape of the bite marks can be different. This is what often confuses examination [4,13].

Bitemark distortion can also occur due to the skin tissue itself. An acute inflammatory reaction on the skin can affect the analysis of the bite pattern because the inflammatory area can cover the tooth mold of the suspect. In addition, often, the bite marks will experience excessive ecchymosis and abrasion, where the bruise extends outside the area of trauma, usually associated with pathological conditions or when trauma is made on tissue that was previously a scar. Subsequent distortion is caused by the rapid disappearance of skin depression. Depressed skin depression will disappear within 20 minutes, even though it is depression that reveals the most valuable physical information in bitemark [14].

2.2. Variables that influence bitemark clinical appearance
Bitemark analysis is often also constrained by the healing process of the human skin itself. With this healing process, bitemark analysis has become ineffective because the shape of the bite mark has changed a lot [10]. In addition, the clinical appearance of bitemark is also influenced by a variety of conditions, namely the structure and vascularization of the bitten tissue. Bite victims are children, adult, or elderly, the general health status of the victim, medication, and bite pressure given [2,10].

Bruises that occur in tissue rich in vascularization will be more visible than non-vascularized tissue. Then the tissue that experiences avulsion or more severe tissue damage will be seen in elderly victims. This is because the elasticity of the skin tissue of the elderly is not as good as when they were young. In addition, the systemic condition of victims who experience hypertension, problems with blood coagulation and impaired liver function, will experience larger, severe and prolonged bruises. Medication also plays an important role in the clinical appearance of bitemark; in people who routinely take aspirin, bleeding will be more and more due to the nature of aspirin in the form of anticoagulants; while in people taking steroids, there is a change in the level of dispersion of the bruise. While the pressure from the bite given will have an effect on the severity and severity of the bitemark and will also prolong the process of healing the tissue [10].

2.3. Distortion of tissue due to pathological processes
Tissue distortion due to pathological processes differs from one person to another. The factors depend on various things that have been explained above. Besides being caused by pathological processes, tissue distortion is also caused by physiological factors and post-traumatic characteristics. Tissue elasticity and relaxation produce different levels of distortion from one network to another. Characteristics of the type of injury to the skin is also an important part because it will be used as a base for determining the severity of the injury. The implication of this is that it will be used as material to sentence the defendant to the level of violence he has committed [15,16].

The physiological characteristics are influenced by the thickness of the skin, where thinner skin will be easier to identify and bite marks will appear more clearly and firmly. While pathological characteristics are influenced by various pathological conditions on the skin that can change the appearance of bitemark, such as disorders of coagulation factors such as hemophilia, Von Willebrand, Bernard-Soulier Syndrome, Glanzmann thrombastenia, liver disorders and vitamin deficiencies, especially vitamin K; platelet disorders both congenital (Glanzmann thrombastenia, Bernard-Soulier syndrome, gray platelet syndrome) and acquired (myelodisplastic syndrome, thrombocytopenic / ITP immunity purpura, etc.); Danlos and Marfan Syndrome, etc. Meanwhile, post traumatic characteristics are tissue changes due to traumatic events that are not directly related to kinetics due to bites, such as tissue edema and other inflammatory markers, as well as scarring phenomena during the healing process [14].

2.4. Post-bitemark wound healing
Wounds inflicted by bitemark usually are scratches, bruises, and sometimes tears in the tissue.[17] Wound pathophysiology and healing processes need to be known by forensic odontologists in order to
estimate the actual shape of the wound so as to minimize bias. The process of wound healing can be broadly divided into two, namely tissue repair and tissue regeneration. Network regeneration will produce new networks that are as good as old networks that are damaged. However, tissue repair will result in scarring [18,19]. Then, if divided according to the type of injury and healing time, the healing is divided into three, namely primary, secondary, and tertiary [20].

Primary healing occurs if the wound from a bite is minimal and can heal on its own. Wounds like this will heal with scars that are clean, neat, thin and faint. This primary closure, aside from the head and neck, can be done safely up to a maximum of 19 hours after the injury. While sores on the face and neck can be closed first by using sterile gauze, as long as the symptoms of infection are not visible. If signs of infection actually appear, then the gauze can be removed first so that the developing anaerobic bacteria can die from the process of exposure to air injury. Within 24 hours, neutrophils will begin to appear at the edge of the incision and then move toward the fibrin clot. Epidermis conjunctivitis will be reshaped within 24-48 hours. On the 3rd day, neutrophils largely disappeared and were replaced by macrophages. On the 5th day, the incision chamber was filled with granulation tissue, neovascularization maximally. Entering the 2nd week, there will be a continuous accumulation and proliferation of fibroblasts. Within one month of the injury, the scar will consist of cellular connective tissue without inflammatory infiltration, covered by the epidermis intact [19].

Secondary healing is when there is a broader and more massive cell loss or a surface wound that creates a large defect, the reparative process becomes more complicated and difficult. Granulation tissue will form from the edge to complete repair [20]. Wounds of this type will heal with worse scars. Some things from secondary healing are different when compared to primary healing, namely a more severe inflammatory reaction, the amount of granulation tissue formed is far greater, and the contraction of the wound is far more [19].

Tertiary healing is delayed wound healing, which is above 4-6 days. The process occurs when the wound has an infection or there is another injury in the same place. This open wound is then closed mechanically. This type of injury usually forms after granulation tissue has appeared [19]. These healings are also classified by several other researchers into four phases, namely hemostasis, inflammation, proliferation and remodeling. Each of these phases has a characteristic and sometimes overlaps between one phase with another phase.

3. Conclusion

Bitemark is still a debate to be used as a basis for consideration to ensnare a suspect because there are many false positive or false negative cases involving bitemark analysis. The mistaken identification is due to the distortion effect caused by the tissue where the bite was made. One of these distortions is due to the process of pathobiology and healing in the injury. Therefore, it is important for a forensic odontologist to know the clinical appearance of the healing process in order to be able to carry out a comprehensive and in-depth analysis of the bite marks.

The author realizes that this manuscript is a preliminary text because there are still very few manuscripts that discuss the pathobiology of the former bitemark network. With the research on the pathobiology of the former bitemark tissue, it can also be estimated that the injury occurred some time ago, so the findings are very useful in the judicial process and the identification process.

Various studies have been developed from the beginning of the development of the degree of tooth wear for estimated age until now. Research has also been carried out in many countries to determine the ability and accuracy of methods that use teeth as a tool for estimating age. With the development of age estimation methods using the degree of tooth wear as an indicator, there needs to be standardization that is used internationally. However, keep in mind that tooth wear is influenced by many factors, not just aging. So it needs to be considered to combine the degree of wear assessment for age estimation with other assessments so that the results obtained are more accurate.
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