

The First Case Report about Noninvasive Impression Taking in Orthodontic Patient with Epidermolysis Bullosa

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Abstract

Bullous epidermolysis (BE) is a rare genetic disease that manifests itself already in early childhood, resulting in impaired expression of protein genes responsible for the connection of skin layers / mucous membranes.

An 11-year-old girl suffering from simple Bullous Epidermolysis (BE) needed orthodontic treatment. The method for obtaining "digital" prints using optical scanning was chosen as the method for obtaining atraumatic negative tissue imaging in the zone of interest. The scanner used in this clinical case works on the principle of triangulation. Understanding the degree of skin and mucosa sensitivity of the patients with BE to the mechanical stimuli is important for making a choice of getting information about dental arch and ways of taking the impression at the initial stage of treatment planning. Taking-off the traditional highly-accurate impressions by polysiloxane-based impression materials in patients with BE were excluded because this method involves taking an impression in two stages to achieve a better result. An option to cast impressions with polyether material, given its high thixotropy was also considered. But with that option there would be difficulties in extracting such an impression from the oral cavity due to the hardness of the material after the end of the polymerization process, which was attributed to a high risk of tissue trauma.

Intraoral scanning is the only atraumatic way to obtain the information about the teeth and mucous membrane health in patients with its pathology due to epidermolysis bullosa. This imprinting method should be the method of choice for such patients.

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Introduction

Today, Bullous epidermolysis (BE) is incurable. But the timely diagnosis and proper care, as well as the management of the patient using special dressings and progressive methods of medical care, can relieve the patient from suffering and ensure his safe existence in society.¹ The provision of dental care requiring imprinting remains an actual problem in the treatment of such patients.^{2, 3, 4}

It became possible to fix atraumatic reproduction of the tissues of the prosthetic bed and to make orthodontic and orthopedic constructions based on these data.⁵

Diagnosis and etiology:

Bullous epidermolysis is a rare genetic disease that manifests itself already in early childhood, resulting in impaired expression of protein genes responsible for the connection of skin layers / mucous membranes. Currently, BE is registered in 1 out of 30,000-1000000 people.^{6,7}

The most common type of the disease is simple EB. Its occurrence in the population is 1: 100 000. The skin and mucous membranes of patients are very sensitive to mechanical stimuli.⁸ This leads to low erosion resistance.⁹ Therefore, such patients are metaphorically called "butterflies", comparing such sensitive skin with the fragility of the butterfly wing. With any mechanical injury, and sometimes without it, bubbles appear on the patient's skin and spontaneously open due to peeling of the skin. This is the reason for the formation of open wounds, requiring the use of dressings to prevent

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infection of the affected areas and to limit the risks of repeated tissue damage.¹⁰

Case report

An 11-year-old girl suffering from simple BE needed orthodontic treatment, that is why her parents were seeking medical assistance from a specialist. During the examination, the orthodontist decided to consult the patient with the specialists to take a codecision of possible ways to reduce the mechanical stimuli on the skin and mucous membranes during diagnostic procedures. A written consent was obtained from the patient's parents. The study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000, and was approved by the ethical committee of the University.

Treatment objectives were:

- to get impressions of the patient's maxilla and mandibula.
- to get registration of the jaws' interrelation.
- to cast dentals model and analyze them.
- to prepare the patient for orthodontic treatment.

Treatment alternatives for getting impressions were

- taking-off the traditional highly-accurate impressions by polysiloxane-based impression materials or alginate impression material;
- getting "digital" impressions with use of optical scanning ("powder" and "powder-free") of the tissues of the oral cavity.

Treatment progress

The method for obtaining "digital" prints using optical scanning was chosen as the method for obtaining atraumatic negative tissue imaging in the zone of interest (Figs 1, 2, 3, 4). The scanner used in this clinical case works on the principle of triangulation.



Figure 1. View of the "digital" imprint of the patient's maxilla in a transverse plane.



Figure 2. View of the "digital" imprint of the patient's maxilla in a frontal plane.

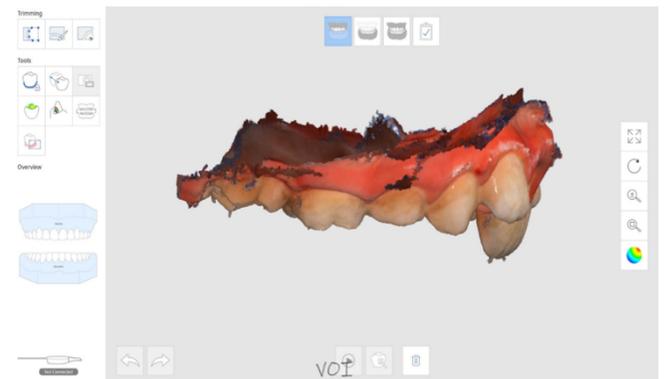


Figure 3. View of the "digital" imprint of the patient's maxilla in a sagittal plane on the right.

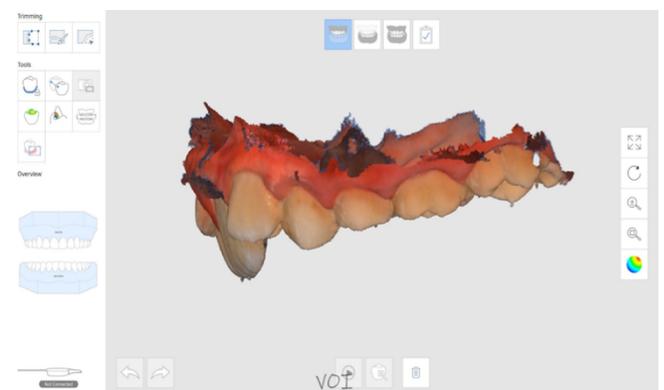


Figure 4. View of the "digital" imprint of the patient's maxilla in a sagittal plane on the left.

The obtained three-dimensional scans of the jaws were sent to a program for virtual modeling of the new position of the teeth. Keeping in mind that during the work with such patient, it is necessary to minimize all manipulations in the oral cavity to fit or correct any dental structures, as this can cause a trauma to the mucous membrane and skin, it was decided to create a "real" model based on the scanned one, for what a 3D printer was needed.

Treatment results

Using Exocad software, the obtained patient's scans were processed and virtual

models similar to gypsum ones were created on the basis of them. Next, virtual models were prototyped using a 3D printer that works under DLP technology (Fig 5). Models made by this printing method have an accuracy along the XY axis ranging from 0 to 40 microns. This is a valid result, why this technology was chosen for use.



Figure 5. The prototype model of the alveolar bone and teeth of the maxilla, made by 3D prototyping according to the template of a virtual model.



Figure 6. Scan of maxilla of the patient with epidermolysis bullosa for non-contact examination and description of the oral cavity state.

Having received the model of the maxilla by 3D prototyping, all the technical stages of modeling and fitting can be performed on it. If consider it as an inescapable stage of a work during orthodontic treatment, then this can be easy done and repeated, using digital technology.

In addition, it should be noted that by performing of optical scanning of the jaws, the obtained full-color images have high detail and excellent clarity, which allows working with the

derived 3D models in virtual space and using the obtained data as an alternative to photo-documenting the state of the teeth and surrounding tissues. (Fig 6).

Discussion

Understanding of degree of skin and mucosa sensitivity of the patients with BE to the mechanical stimuli is important for making a choice of getting information about dental arch and ways of taking the impression at the initial stage of treatment planning. Taking-off the traditional highly-accurate impressions by polysiloxane-based impression materials in patients with BE were excluded because this method involves taking an impression in two stages to achieve a better result. An option to cast impressions with polyester material, given its high thixotropy was also considered. But with that option there would be difficulties in extracting such an impression from the oral cavity due to the hardness of the material after the end of the polymerization process, which was attributed to a high risk of tissue trauma.¹¹

The next material of choice was alginate impression material. However, after analyzing its properties (poor display quality of the prosthetic bed tissues and, like the other materials examined, the mechanical effect, which may cause a minimal, but trauma), this material was also excluded from the selection.¹²

Having made sure that all available impression materials can cause tissue damage in a patient with BE to one degree or another, it was decided to pay attention to innovative methods of getting impressions, and more precisely, to the method of obtaining information about the patient's dental arch by a digital method - by intraoral scanning.

Currently, there are several methods for getting such "digital" impressions. The scanners used for these purposes are divided into "powder" and "powder-free". The principle of work of optical "powder" scanners consists in applying a spray with an anti-reflective component to the teeth. This spray, covering the teeth with a matte layer, creates the settings for the scanner to perceive the relief of the surfaces of the tissues of the oral cavity during its work, which allows to take information about the dental arch.¹³

At the moment, "powder-free" devices

have appeared that scan the dental arch without the use of a matting spray. The principle of getting a three-dimensional image from such scanners is optical triangulation. This is an amply high-precision method of obtaining a complex three-dimensional image in such difficult places as the oral cavity. The tooth enamel, having a dry glitter, significantly complicates the scanning process, and soft tissues (tongue, cheeks, transitional fold) that can be shifted during scanning "interfere" with continuous image acquisition.

3D scanners, which are based on the principle of triangulation, are active scanners that use optical light to study the scanned object. If you evaluate a three-dimensional optical scan while making a move, the triangulation light source directs the light to the object and then through the camera localizes the light point. Depending on how far from the source the light beam comes into contact with the study surface, the appearance of an optical point is registered in different places of the camera's field of view. This method is called triangulation, because a triangle is virtually formed between the laser point, the camera, and the light emitter. The length of one side of the triangle (the distance between the camera and the light source) is known. The angle of the laser emitter angle is also known. The angle of the camera angle can be determined by looking at the location of the laser point in the camera's field of view. These indicators determine the shape and size of the triangle and find the position of the point angle of the triangle. This scanner was used in this clinical case.

The most important criterion for choosing of an optical scanner during the work with a patient suffering from BE was the fact that when this kind of three-dimensional image is received, there is no mechanical stimuli on the mucous and soft tissues of the oral cavity. As a result, injury does not occur if this technology is used. This extremely favorably affects the overall result and the consequences of received information about the state of the oral cavity and dental arch in a patient, especially with BE, rather than in the case of using the traditional method where any available impression materials can be applied.

A huge advantage of optical scanning of the tissues of the oral cavity is the ability to immediately evaluate the received information about the dental arch. A digital three-dimensional jaw model is displayed on a computer screen in a

short period of time (up to 5 minutes), which allows you to immediately analyze the quality of the received data and makes it possible to start working with this information or to send it to a related specialist anywhere in the world for a joint consultation.

All information that is displayed in real time while obtaining the information by optical scanning, arrives on the computer screen in the form of a polychromatic image. The colors of the resulting three-dimensional image are as close to a natural one as possible (subject to calibration requirements). This allows to evaluate the quantity and quality of the received information, to assess the presence of unscanned areas (empty spaces in the 3D model) due to flecks on the teeth or excessive moisture in certain areas. Moreover, the result can be immediately demonstrated to the patient during the consultation in order to clearly explain the incomprehensible stages of work by adding a digital photograph of the desired segment.

Almost all modern scanners have the ability to upload the received data to third-party software for orthodontics. For the described clinical case, the STL format was used. This is a publicly accessible file format that can be opened by any program for viewing three-dimensional files. It is very valuable when such data contains information about the color of the scanned object, and the program into which they are loaded can read and decode them.¹⁴

In addition, when you receive impressions by the traditional way, there is a risk of receiving pores or guy lines, which negatively affects the quality of gypsum models and, therefore, the constructions made on them. In the case of getting "digital" impressions by optical scanning, this error is eliminated. Of course, there may be other mistakes, but, as described earlier, they will be identified immediately upon receipt of "digital" impressions, which allows you to immediately eliminate them.

An additional advantage is the ability at any time to get an unlimited count of such models. For example, to receive of a distant consultation with related specialists or with colleagues from other regions and countries. Or to develop manual skills during working with similar difficult clinical cases.

Conclusion

Intraoral scanning is the only atraumatic way to obtain the information about the teeth and mucous membrane health in patients with its pathology due to epidermolysis bullosa. This imprinting method should be the method of choice for such patients.

By virtue of color reproduction, the modern capabilities of scanners make it possible not only to assess the spatial position of the teeth, but also the mucosa state, and to take note of areas of hyperemia or cicatricial changes.

This method is not time-consuming and does not require additional documentation, which is a valuable quality for dentists who are actively involved in clinical practice.

The ability to cast a physical dental model based on the scan results for carrying out or checking of the work technical stages is an additional advantage, as it allows you to predict the result or correction in advance at any stage of the work.

It should be noted that this method of getting impressions is also "attractive" for patients. After such a procedure, they will certainly strive to comply with the doctor's recommendations, since the process of getting impressions does not cause a negative reaction, since there is practically no mechanical effect on the patient's mucous membranes. The only contact of the mucous membranes with the doctor's instruments occurs during retraction movements with a mirror, which is necessary to provide access to the teeth and the area of the attached gingiva.

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The authors declare no acknowledgement.

Declaration of interest

The authors declare no conflict of interest.

Consent

The patient's parents agreed the doctors could use and publish their daughter's case report EB disease related article with personal information deleted.

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