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# Demonstration of skull bones mobility using optical methods: practical importance in medicine

Alexander V. Zakharov*[a], Vladimir R. Okushko[b], Sergey A. Vturin[c], Vladimir V. Moseychuk[a], Aleksey A. Petrov[d], Dmitry E. Suetenkov[e]

[a]Noospheric Health Center, Moscow, Russia; [b]Pridnestrovian State University n.a. T.G.Shevchenko, Tiraspol, Transdniestria; [c]Space Research Institute RAS, Moscow, Russia; [d]Avroraclinic, Moscow, Russia; [e]Saratov State Medical University n.a. V.I.Razumovsky, Saratov, Russia

## ABSTRACT

Unprompted skull bones mobility not related to breathing, heart beating and other physiological reactions, using installation of original construction with control of physiological parameters by biofeedback hardware-software complex BOS-lab and BOS-pulse appliance (COMSIB, Novosibirsk, Russia) has been confirmed. Teeth eruption occurs through odontiasis canals, emerging from the funiculus. The main driving force for promoting a tooth into odontiasis canal during eruption is the unprompted skull bones mobility. A simple optical installation was made for the visualization of skull bones mobility during the investigation of the median palatine and incisors sutures. Early detection of failures of unprompted skull bones mobility and its normalization can lead to prevention of impact teeth, malocclusion, extrudocclusion and other anomalies and deformations of teeth, teeth rows, TMJ and skull. The skull bones mobility should be considered during the early preventive treatment and therapy of the consequences of injuries and malfunction of the maxillofacial area.

**Keywords:** skull bones mobility, preventive medicine, tooth eruption, optical methods of registration, biofeedback appliance.

## 1. INTRODUCTION

Medical science has two popular viewpoints regarding the skull anatomy. Some scientists claim that at least by the age of 20-30 years[1] the skullcap, and later[2], the whole skull becomes integral[3]. Others[4] argue that the skull bones don’t anchylose throughout the lifetime[5]. Among second group of scientists is M.L. Moss, who believes that the face growth is influenced by functions and occurs because of soft tissues environment of bones[6].

Thus the growth continues even for adults. R.G. Behrents investigated X-ray films taken with a 40-years interval. He observed the frontal growth (deformation) of the jaws and a significant modification of the nose[7]. After the growth areas disappear, bones can grow only in the presence of a seam or an injury. That was proved by the Soviet practical scientist, doctor D.A.Ilizarov[8].

It means, the skull bones do not anchylose. To prove this, 150 skulls were examined from the collection of the Saratov State Medical University n.a. V.I..Razumovsky, Department of Human Anatomy. 95,5% skulls of people, dead in the age of 35-80 years, looked as a single unit without sutures, and only 4,5% skulls of people, dead in the same age, but consisted of separate bones, bound to each other with wire elements (Figure 1).

The difference in the structure and condition of the skull bones can be explained by medicolegists[9]. It is very important to observe the rules of a dead body maceration and of the fabrication of skull bones macro-specimen, which is not always possible, because the original quality of a dead body is often not suitable for a quality product fabrication. Different condition of osseous structures and seams of skull is even used by medicolegists to indirectly determine the time of death and the conditions in which the dead body was.

* zallev@gmail.com; phone +79153245297; nooscentr.ru

Figure 1. Skullcaps belong to men 36 (left skull) – 40 (right skull) years of age from collection of the Saratov State Medical University n.a. V.I.Razumovsky, Department of Human Anatomy.

According to the «Atlas of human anatomy» by Sinelnikov R.D.[10], upper jaw – is double bone, each consists of 3 bones: incisor bone or premaxilla, palatinal processus of upper jaw and horizontal lamina of palatine bone. Muscles attach to those bones. Muscles in the maxillofacial area are the strongest in the body, capable to exert forces up to 500 kg per square centimeter. Thus, the skull bones can be easily shifted, which may result in teeth repositioning or a teeth load variation.

Besides, the skull bones have unprompted mobility not related to breathing, heart beating and other physiological reactions. Andrew T. Still was the first to openly discuss this among the medical scientists[11].

Palpation was the first evidence of skull bones mobility, then it was Galvanomagnetic effect[12]. The most successful evidence of skull bones mobility was the computer analysis of the brain electrical impedance pulsation and the transcranial doppler-graphy that of Y.E. Moskalenko[13]. Meanwhile this method often requires the implantation of electrodes in the brains of a human or an animal, and involves the application of a very expensive and special equipment, which is possible for a fundamental science rather than for a clinical practice.

## 2. METHODOLOGY

The goal of the paper is to experimentally prove the skull bones mobility in the dynamics of unprompted movement of upper jaw bones in the median palatine suture.

Objectives:

1. Develop and create a technical device for the video registration of upper jaw bones movement.

2. Register the upper jaw bones movement.

3. Instrumentally record the physiologic activity of brain, masticatory and trapezius muscles, and heart beats.

4. Compare the received physiologic parameters with the diagram of unprompted movement of upper jaw bones in the median palatine suture.

A light emitter is fixed on one central incisor of the left upper jaw, and a registration device is fixed on the other central incisor of the right upper jaw (Figure 2).

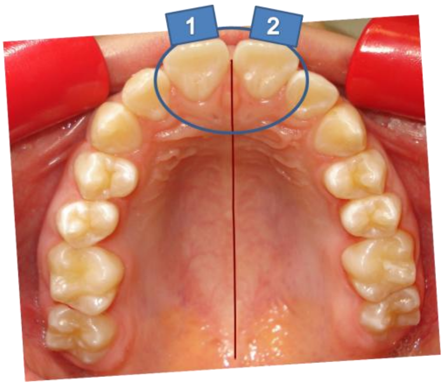


Figure 2. A layout of the median palatine suture and the configuration of 2 central incisors. 1 - registration device, 2 - light emitter.

In the next set of experiments we used 2 video cameras fixed at the right angle to each other. We also used better focusing light emitters, which we soldered at the right angle in line with the cameras. We chose 2 superbright LEDs, made with gallium arsenide superbright LED, and connected them through a 15 Ohm resistor to a 1.5 VDC source (Figure 3).

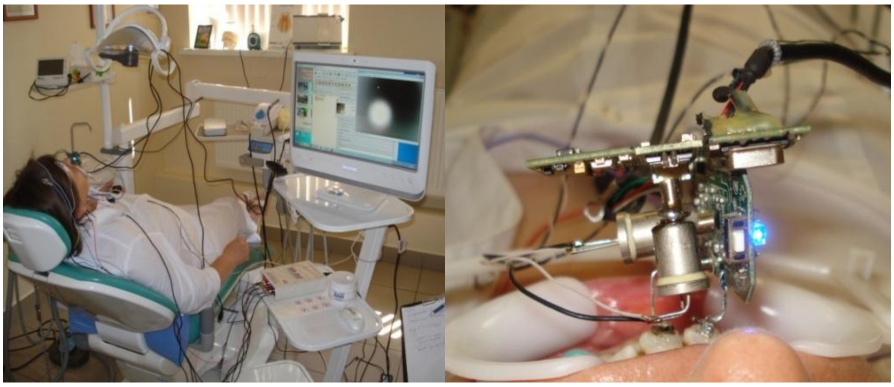

Figure 3. Installation recording the skull bones mobility: A. A general view, B. A close-up view.

We used a biofeedback hardware-software complex BOS-lab and BOS-pulse appliance[14] (COMSIB, Novosibirsk) to register the physiologic parameters and to simultaneously record several parameters of EEG, integral EMG of the masticatory and trapezius muscles, and a BOS-pulse appliance (COMSIB, Novosibirsk) to register the pulse rate during the experiment.

## 3. DATA

Primary data received were 159120 shots in 4 parts of the experiment. The frame rate is 30 fps.

Sub-task description - to transform a set of images (or video frames) into a set of numeric data to reflect the skull bones mobility.

Processing steps:

1. Use the image to choose the characteristic parameters dependable on the variation of distance and the relative position of the sensors fixed to the skull bones.

2. Estimate the values for each frame of the observation sequence.

3. Analyze the received sequences

We need to choose the characteristic parameters of the image, the change of which depends on the modification of the required parameters (Figure 4). For such parameters we suggest using the size and the position of the light spot as registered by the camera matrix from the source.

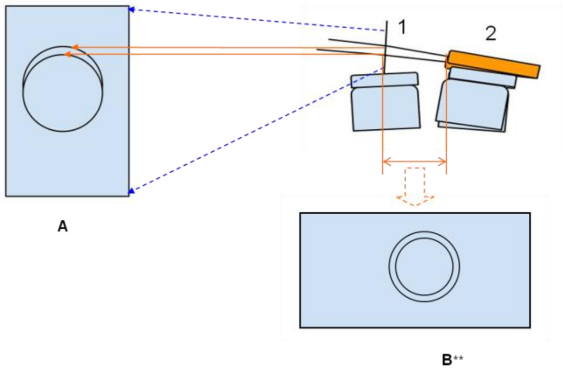


Figure 4 Choice of image characteristic parameters A - Light spot shifting can be indicated as a mass center re-coordinating; B - The change of distance between the detector (1) and the sensor (2) can be indicated as a change of the light spot area size.

The initial image has a few features complicating the adequate estimation of the required parameters (Fig. 5).

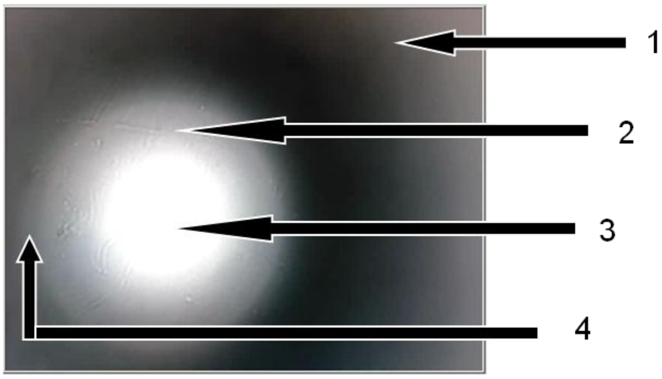


Figure 5 The structure of initial image received in series of experiments: 1 - External interfering exposure; 2 - Peripheral exposure; 3 - Valid signal; 4 - A possible exposure shifting to the outside of the frame.

To avoid the above effects, a set of simple transformations is used to retain the useful information. Resulting frame is clear and prepared for the parameters estimation. The input program data is a set of images (video frames), wherefrom using a simple image processing method we can estimate the values of the required parameters – mass center coordinates and the area estimation.

$$\hat{S} = \sum b_{x,y} \qquad \hat{P} = \frac{\sum b_{x,y} \cdot \vec{p}}{\hat{S}} \tag{1}$$

To improve the accuracy and to account for the edge diffusion effect, a proportional value $\hat{S}$ has been chosen to estimate the area: a sum of brightness values $b_{x,y}$ of the whole light spot area. Then light spot mass center coordinates $\hat{P}$ are estimated according to the formula (1) where $\vec{p}$ is a position of current pixel with brightness $b_{x,y}$.

The received data can be visualized in a form of diagrams, where the character of changes is shown (Figure 6).

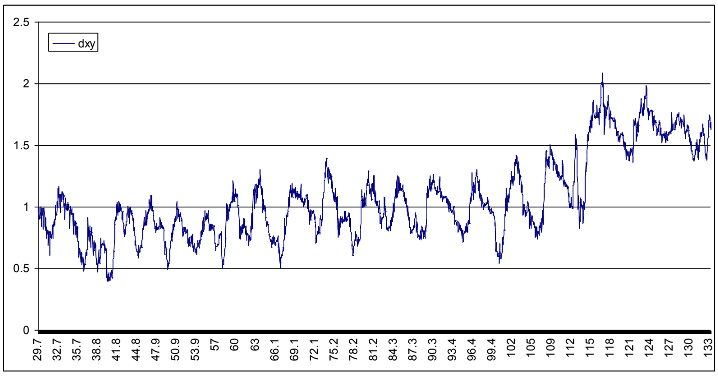


Figure 6. A valid signal fragment, demonstrating unprompted skull bones mobility.12 cycles per minute.

## 4. RESULTS

The received diagrams of the skull bones mobility (Figure 6) are different from the diagrams of breathing and pulsing as registered with the BOS-Pulse device, and from other Diagrams of all physiological parameters (Table 1), synchronized with a flashlight at the beginning of the experiment.

Table 1. Comparative table of physiological parameters obtained in the result of the experiment and ranked by the number of oscillations per minute.

| Physiological parameter | The frequency per minute | Recording device |
|---|---|---|
| EEG, Alpha | 2-3 | BOS-lab |
| EEG, Beta | 2-3 | BOS-lab |
| EEG, Teta-Beta | 3-4 | BOS-lab |
| Integral EMG of the masticatory and trapezius muscles | 3-4 | BOS-lab |
| Unprompted skull bones mobility | 12 | Our installation |
| Breathing | 15 | Our installation |
| Pulse | 67 | BOS-pulse |

The received numeric values of the frequency of the unprompted mobility of the skull bones in the median palatine suture are 6-15 cycles/minute and correspond to the information in the scientific papers, i.e. 6-15 cycles/minute[13].

Pridnestrovian scientists have proved that a tooth formation is accompanied by the appearance of a funiculus which then transforms into the odontiasis canal (Figure 7). Dentition canals of canine and second premolar teeth are either anatomically or functionally interconnected with skull seams. If the unprompted skull bones mobility, a major factor of teeth eruption, is impeded due to an injury of the child in an early age or at the prenatal stage, it may result in extrudocclusion or impaction.

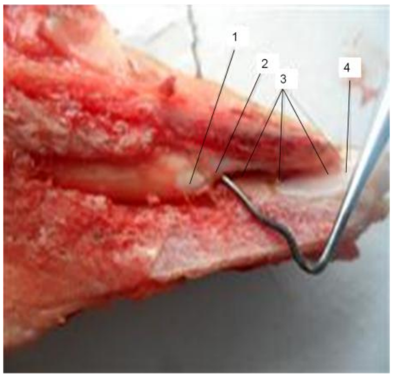


Figure 7. A fragment of a pig's lower jaw (specimen of T.A. Chependuk, V.R. Okushko): 1- A germ of the permanent incisor; 2- fibrotic fold; 3- bone canal; 4- bone canal exit.

Once the skull bones mobility is normalized, an unprompted odontiasis (eruption) occurs. Meanwhile, the location of the frontal incisor remained unchanged and even slightly improved. When the skull bones mobility is normalized, together with the orthodontic treatment it results in reshaping the facial features and even the body posture.

## 5. CONCLUSIONS

1. The skull bones mobility has been experimentally proven by means of a new simple optical device;

2. The received data were proved to be different from other physiological parameters;

3. The importance of an early detection and normalization of the skull bones mobility has been proved by the example of patients under the orthodontic treatment.

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