SYNTHESIS OF TEHCNOLOGY AND MEDICINE: 3D PERIODONTAL MODEL FOR TEACHING

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Abstract

Modeling teeth and gums with three-dimensional graphics program *Autodesk Maya* is analyzed in this article. 3D graphics provides a better understanding of periodontal tissues, gingivitis and periodontitis as well as alterations caused by them. The model created with Autodesk Maya program has been used as students teaching device by the lecturers of Oral Helath Department at the Faculty of Medicine, Kauno kolegija/University of Applied Sciences for several years.

Keywords: *3D, teeth and gums modeling, Autodesk Maya, three-dimensional graphics*

Introcduction

Periodontal diseases can occur at any age. Some people notice the signs of periodontal diseases since they are 18, and every second individual suffers from periodontitis since they are 35. The first signs of disease appear as painless but with bleeding gums while brushing teeth.

Periodontal diseases are caused by bacterial infection which damages the gums, bone and ligaments that attach teeth to the jaw (figures 1 and 2).

Fig. 1. Tooth section – healthy periodontium, gingivitis, periodontitis.

Fig. 2. Healthy periodontium, gingivitis, periodontitis

Periodontium is functional structure of the tissues surrounding the teeth. Periodontal tissues comprise gums, periodontal ligament, elveolar bone and cementum (Pūrienė, 2008).

Periodontal diseases localize in soft tissues surrounding a tooth and bacteria is the most common reason for it. There are plenty of microorganisms in the oral cavity and plaque. The diseases of these tissues are some of the most common causes of tooth loss.

Gingivitis is a type of periodontal disease in which alterations of teeth color, shape and texture take place (Andruškienė, 2012). Its main cause is accumulation of bacterial plaque. The severity of inflammation can be influenced by such factors as filling edges, dental calculus, systemic diseases, medication use and irrational nutrition (Rimkevičius irk t., 2014). Gums become more and more swollen, bright red in color, bleed due to lasting inflammation and blood circulation disorder and turn bluish.

Periodontitis is an advanced stage of disease, destruction of tissues when damage is caused to only to gums, but to bone and other tooth surrounding structures as well. In case of periodontitis gums are red, bluish, marginal gingiva is altered, gums bleed while brushing teeth and pain appears while eating. Gums develop an abscess, teeth become lose, fall out due to destruction of tooth supporting ligament, a part of jaw bone is dissolved and lost (Rimkevičius irk t., 2014).

Formation of teeth and gums model

3D graphics is a rational choice for visualizing objects comprehension of which is rather complicated. It is used in games, filming industry, interior and exterior visualization and in medicine. 3D graphics Autodesk Maya was chosen for teeth and gums modeling. Models were visualized according to the pictures loaded into all three projections using polygons method. For tooth and gums models cubes were created made of divisions of component edges of width, height and length. Modeling was processed by manipulating

points, edges and surfaces from all present projections till the desired result was achieved. The points were manipulated using *Move, Scale* and *Rotate* Tools. *Sub-division* was used in order to smooth the contours of the object (see figure 3).
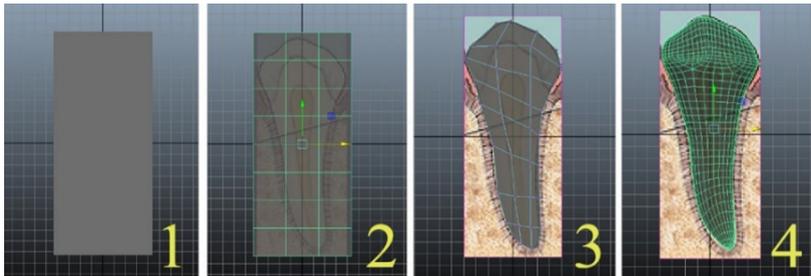

Fig. 3 Tooth modeling

The functions used were as follow: : *Extrude* – in order to extrude surfaces; *Beviel* – to smooth shape of certain edges, *Insert Edge Loop Tool* – to add additional annular rims. *Soft Selection* was used as well in order to mark more than one point, edge or surface.

A tooth was cut into halves. The action of cutting can be done in two ways: by using a new object and *Mesh>Booleans>Difference* command or by marking half of tooth's surface, deleting it and filling the rest of the hole using *Mesh>Fill hole* command. The method of deleting surface and filling the hole was chosen, since having done it, a completely neat cut surface is achieved which can be further used in order to visualize tooth's structure (figure 4).
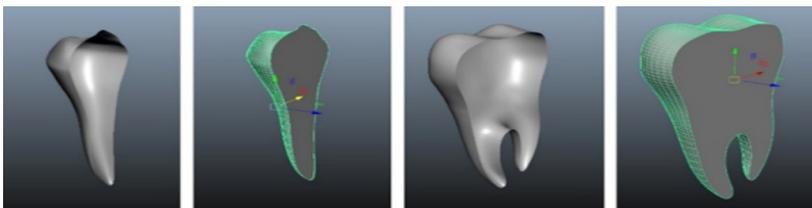

Fig. 4. The surfaces of the fourth tooth and fifth tooth halves deleted and then filled.

In order to finish off gums modeling *Sculpt Geometry Tool* was used, which only works successfully having a high object surface Sub-division

number. Gums were applied the second division level, and in the places which contain the largest area of formed surface annular rims were added. In total, the object of gums was made of more than 50 000 surfaces, but it enabled modifying gum pockets well without overloading work scene. Modification took place applying *Push*, *Pull* and *Smooth* tools till the desired result was achieved (see figure 5).
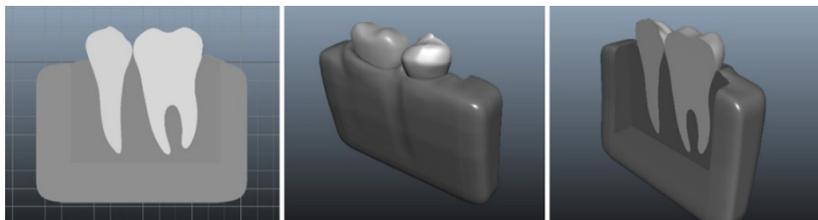

Fig. 5 Modeled gums

Geometry of the object changes using different modeling tools. A primitive object of polygons turns into a complicated object with a distorted position of edges, surfaces and points. This situation led to creating UV retina and preparing gums for further modifications including textures (figure 6).
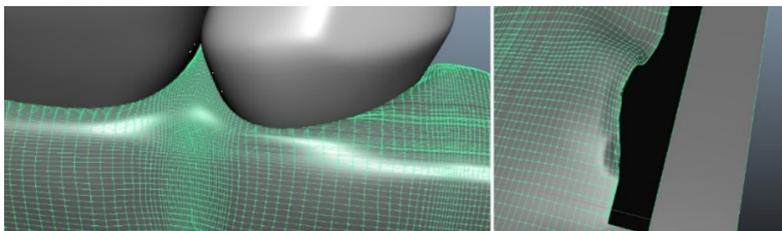

Fig. 6. Inaccurate geometry of gums

Later geometry was recovered: an absolutely new geometry of gums was newly created without losing shape of the gums. Recovery process takes place directly in *Autodesk Maya* program using a renewed *Quad Draw Tool*. At the beginning of the process the target object had to be turned into *Live surface*. It is a kind of redrawing of the object by placing points and turning them into surface. Having recovered the object, a number of surfaces was reduced from 50 000 to 2 500. Having used a second level division number for further modification, a number of surface units would be even 10 000 less that before object's geometry recovery (figure 7).
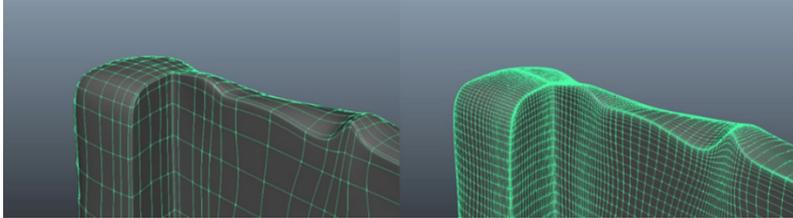
Fig. 7. Newly recovered geometry of gums

Conclusions

The main purpose applying and using a contemporary 3D model is to provide a student with a view as close to the reality as possible. In the process of Oral Hygiene study program, during which such objects as periodontal tissues are studied, using interactive multimedia devices ensure more efficient learning and makes completion of tasks easier. The mentioned device provides a better understanding and comprehension for students. Visualization by two-dimensional device contains lenght and width likewise 3D, but it lacks the additional dimension of depth. The drawback of 2D application is the loss of realistic connection. Using 3D model allows seeing the object, rotating and examining its different angles.