Magnification tools in the dental clinical practice – Review

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Методи за увеличение в денталната клинична практика – обзор

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Abstract: *Dentistry has become more sophisticated and complex thus requiring precised motor skills and visual acuity. In past decades, dentistry has not only evolved clinically, but the histological aspects has also played an important part in the development of new materials as well as helped in better evaluation of treatment procedures. Now the use of such magnification systems is a popular practice in dentistry as well. Before adopting visual magnification systems such as microscopes and successfully applying it in the dental procedures, it is mandatory to understand the principles and the physics of such instruments. Microscope was initially used in ophthalmology. Its benefits also extend to all aspects of dentistry including endodontics, periodontics, restorative, prosthetic dentistry, pediatric dentistry, and implant dentistry. Barring the disadvantages of cost and maneuverability of the equipment, magnifications are definitely becoming an important aspect of modern day dentistry, owing to their numerous other benefits. This review paper, highlights about the various magnification systems, its principles and the application of microsurgery in various fields of dentistry.*

Keywords: *magnification, loupes, dental microscope*

Резюме: *Денталната медицина става все по – сложна, което изисква прецизни двигателни умения и зрителна острота. През последните десетилетия тя търпи развитие както в клинично направление, но също така хистологичните аспекти играят важна роля в разработването на нови материали и оценка на лечебните процедури. В днешно време използването на увеличителни системи е популярна практика в денталната медицина. Това прави задължително опознаването на принципите на работа и физиката зад тези инструменти. Оперативният микроскоп е използван най-напред в офталмологията. Неговите ползи обхващат всички области на денталната медицина, включително оперативно зъболечение и ендодонтия, пародонтология, протетика, детска дентална медицина и имплантология. Изключвайки недостатъците като цена и маневреността на оборудването, увеличението се превръща във важен аспект на съвременната дентална медицина поради множеството предимства, които предлага. Този обзор отразява различните системи за увеличение, принципите им и прилагането им в различни области на денталната медицина.*

Ключови думи: *увеличение, лупи, дентален микроскоп*

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The use of magnification tools is a revolutionary step in dental medicine. It has lead to the transformation of conventional everyday macro dentistry to a new high precision micro dentistry [1].

Microdentistry

This is minimal invasive dentistry performed with the aid of any optical device that increases the operative field [2,3].

Microdentistry has proved to be clinically effective and it is considered the new golden standard in dental treatment. With this, new technology protocols of dental treatment are changing and pediatric dentistry is no exception. The use of magnification devices [dental operating microscope and magnifying loupes] is an innovative technology in dental practice, which aids new diagnostic and treatment strategies and their use in different conservative and surgical treatment modalities.

History and terminology

Humanity has sought for methods to improve eyesight through use of different magnification tools for centuries [5]. It is known that 2800 years ago lenses were used to improve vision impairment of people. Integrating optical devices in clinical practice dates rather recently and their use at first is sporadic [2,3,6].

The first magnification tools in medicine were used to aid surgical treatment in the late 1800. The first operating microscope in medicine was introduced in 1950. It has been created by Carl Zeiss Company and had coaxial lighting system and stereoscopic view [1]. The first microscope in dental medicine was introduced by Apotheker and Jako in 1978 [3,7]. Microscopes have been used in endodontics since 1986. In 1992 microsurgery was introduced into periodontology through the use of operating microscope [1]. Since 2005 microscope training has been included for students in some dental schools [5].

Magnification

This phenomenon makes possible to see the object larger and to use this enlarged, magnified image or model.

Magnification in dental medicine

There are several methods of magnification. Magnification devices vary in their technical capabilities, optical quality, size of magnification and price. From all available methods for magnification, magnifying loupes and operating microscope are the most popular [5,8]. Both are used routinely in every day dental practice. There are significant differences between both tools in their optical characteristics and in their clinical use and capabilities

Operating microscopes unlike the dental loupes may have six steps of magnification (2,5x, 4,0x, 6,7x, 10x, 16x, 24x) [1,3].

Working distance

This is the distance between the eye of the operator and the treated surface. It is determined by measuring the distance between the front lenses of the microscope and the treated surface. Properly defined working distance makes working with the magnified object easier [9,10].

Depth of field

This is the range of working distances, in which the operator is able to sustain his visual accuracy [5].

Width of field

It is often called "field of view". This is the width and the height of the zone or area that the operator sees on focus, when using the magnifying tool. The larger the magnification, the smaller the size of this "field of view" [9,10].

Deviation angle

This is the degree of the operator's eyes diversion so that he can see the treated area. Angles of deviation vary from 15° to 44° [11].

Magnifying loupes

These are the most commonly used magnifying tools by dental practiotioners [3,5,12]. They consist of two monocular microscopes with lenses arranged side by side and oriented in such a way so that they focus on one object [12].

There are different kinds of magnifying loupes, and they differ from one another in construction and design [1,5,6]:

- Simple loupes
- Complex loupes
- Prismatic loupes

Simple loupes

Simple loupes consist of a pair of single, positive lenses, situated side by side. Every lens has two refractory surfaces. The first refraction occurs when the light enters the lens and the other when the light goes through it. Magnification with these tools can be increased only by increasing the diameter or the thickness of their lenses. The size and weight of these loupes limit their practical application in dental medicine [5].

Complex loupes

This kind of loupes have a set of multiple converged lenses. Between these lenses there are air spaces that increase the refractory capability, the magnification, the working distance and the depth of field. These magnifying loupes can be easily adjusted according to the clinical requirements by changing the space between the lenses. Combined lenses can be achromatic. This is important factor when choosing a magnifying tool for the dental practice. These achromatic lenses are effective in creating a perfect color image. The Galilean loupes are also complex. They are cheap and easy to work with compared to other complex loupes. They consist of 2 or 3 lenses which make them cheap and light. Their drawbacks are the limited magnification (2,5 or 3,5 times) and the blurred peripheral boundary of the field of view [13].

Prismatic loupes (loupes with broad working field)

They consist of prisms that refract the light beams. They have a prism on top and are called prisms of Schmidt. These prisms are used to lengthen the path of the light through series of mirrors, placed between the lenses. In this way the system provides better magnification and larger depth of field. This guarantees longer working length and broader field of view. Currently these devices are most advanced magnifying tools on the market. The range of magnification varies between 1,5x and 6x. Dentists usually use surgical loupes with 2.5x-3.5x magnification. Periodontologists prefer 3,5-4,5x magnification. Microsurgery of delicate tissues requires 5,5x-6,5x magnification [5].

Dental loupes are easy to use and do not need significant adjustments in the work process [14]. For all of them it is true that the higher the magnification, the smaller the working area is [5]. Choosing a specific brand or model must be based on all current and future treatment requirements. It is better to buy loupes with the highest possible optic quality to be useful in the future. The biggest advantage of dental loupes is that they are easily incorporated into the work process and space [3].

Operating microscope

Dental microscopes provide much higher magnification and optic characteristics than dental loupes. They use Galilean optics and binoculars, connected with neutralizing prisms so that a parallel optical axis occurs. Galilean optics allow the clinician to have a stereoscopic vision without eye convergence or any eye load. These microscopes provide optimal focus depth and field of view [13].

Surgical microscopes consist of commuter for the magnification, lenses, source of light that illuminates the working area, binocular tubes and eyepieces. The microscope can be mounted

on the wall or ceiling [15].

Microscopes with higher magnification are always preferred. Higher magnification makes the work of the dental practitioner easier. The practitioner develops precision of micro movements and improves his micromotor reflexes, which makes a huge difference when performing microinvasive procedures. In order to achieve this control, big joints like the elbow and shoulder should be in a stable position on the work chair. It has been proved that dentists working without magnification make a lot more movements while working. When using 20 x magnifications, movements are minimized to insignificant 10 to 20 microns [10-20/1000 mm] in real time. It is remarkable that the precision of the procedure depends not so much on the hands or fingers but on the vision [16].

One of the advantages of the microscope is that the dentist can alter the magnification while working so that the degree of magnification is satisfactory for the treatment needed. The presence of additional source of light is another advantage. In that way operating field is illuminated and the practitioner will have a clear vision without shadows [12,17].

Comparison between loupes and operating microscopes

Optical advantages

Microscopes provide 3x to 20x and more magnification depending on the brand and model. Although associated with a heavier and more expensive optical system, this complexity allows using an optimal magnification for each treatment procedure [5]. It is wrong to think that the higher the magnification the better. In reality higher magnifications offer smaller depth of field, field of view and illumination for the operator. So it is better to use the smallest possible magnification, which allows full control of movement. Different stages of dental procedures require different magnification. If the dentist uses loupes, he/she might have to change different pairs through the course of treatment. This will create problems in terms of work flow, ergonomics and will cost more. Microscope optics are more complex, heavier and expensive but of higher quality [3]. For equal magnification microscopes provide better vision than the loupes. Incorporating light in the loupes makes them more expensive, heavier and less comfortable for the dentist. The intensity of the light can be adjusted only by the dentist, which is another disadvantage. Modern microscopes have powerful xenon light and its intensity varies automatically with the magnification used [3].

Ergonomic advantages

Due to its more static design, the microscope limits the need for continuous change in the position of the operator or patient and thus helps the dentist better cope with ergonomic requirements [18].

When working with a microscope the dentist looks straight ahead and not to the operating field and thus he can stay in an upright position and avoid all non-physiological distortions of the spine. Given the high incidence of back pain among the profession practitioners, this argument could justify regular use of the microscope, along with its other benefits.

Unlike the loupes with the converging optics, microscope's optics are parallel, aligned with the axis of vision at infinity. The eyes of the operator do not have to converge or adjust, which removes all the stress, even if he/she uses the highest magnification. At the end of the day the loupes can cause eye fatigue or even headache. Microscopes allow the dentist to stay relaxed during the day, while providing the best quality of vision and comfortable pose [11].

Option for photo and video documentation

Another advantage of dental microscope is the possibility to easily generate photo and video documentation during different treatment stages. Most microscopes can be equipped with standard or high definition camera [5,19]. These tools allow the dentist to create and save images without interrupting the workflow. This is of

high importance in the dental practice nowadays. This option can be used as a communication aid when talking to the patients, technicians, colleagues and others [3,5].

Dental microscope provides [20,21]:

- Excellent diagnostics
- Minimal invasive procedures
- Maximum quality of treatment
- Predictable long-term clinical results in endodontic treatment, especially in immature permanent teeth

Disadvantages

The use of operating microscope requires special training and better manual skills. It requires also longer period of adjustment and longer training. Surgical microscopes are significantly more expensive than dental loupes [5,22].

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