

Optimal Positioning for a Dental Operating Microscope During Nonsurgical Endodontics

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The most comfortable positioning for a dental operating microscope (DOM) during nonsurgical endodontics for operators was investigated. Operators were categorized into 3 groups according to height. We recorded the time taken to obtain magnified images, and the angles of binoculars, microscope body, and the mirror to floor surfaces. For the group of shorter operators, observations were also made with an angled optics or a short objective lens (200 mm). It took longer to observe the mandibular molars than maxillary in every group. Although the differences in angles among each group were not remarkable for maxillary observation, we confirmed significant differences for the mandibular. Shorter operators had to adopt a strained position for mandibular observation in a standard setup but were more comfortable using angled optics or a short objective lens. By understanding the proper position, operators could learn to perform microendodontics more efficiently.

The dental operating microscope (DOM) is now recognized as a valuable tool in nonsurgical and surgical endodontic treatments (1–4), although it experienced a relatively slow acceptance (5). Magnification and intense illumination are the 2 main features of this equipment (6). The reported advantages of using a DOM include locating canal orifices (7–11), negotiating calcified canals (12), placing root-end filling material (3), identifying resected root-end cracks (13), and so on.

However, some practitioners report that the learning curve is steep when the DOM is first used, because of the difficulty positioning the DOM (14). Indirect vision with mirrors is inevitable in nonsurgical endodontics. Mirrors are essential to examine the root end in a shallow beveled preparation in surgical endodontics, although direct vision is preferable over indirect whenever possible (15,16). An optimal operating position with a mirror could be a critical factor in the successful use of a DOM.

Working positions with a DOM have been described in a variety of postgraduate and/or continuing education (CE) courses for microscope training (15,17); however, a definitive position for non-

surgical endodontics has not been proposed. The purpose of this study was to examine the comfortable, ergonomic, and practical position with a DOM and a dental mirror in nonsurgical endodontics, setting out definitive angles to the floor when the operator is at a 12 o'clock position.

MATERIALS AND METHODS

A DOM with inclinable binoculars (OPMI Pico; Carl Zeiss, Germany) in a floor-mounted setup was used. The DOM setup consisted of interchangeable objective lenses (standard: $f = 250$ mm/option: $f = 200$ mm), a 5-step magnification changer, and an integrated video camera connected to a liquid crystal monitor (LC-130F1; Sharp, Tokyo, Japan). We used angled optics (Carl Zeiss), supplied as an optional device by the manufacturer, to obtain a greater distance between the binoculars and the microscope body. In this study, the DOM with standard objective lens (250 mm) and without angled optics is defined as a standard setup.

Teeth nos. 3 and 30 in a dental study model (500A; Nisshin Dental Products Inc., Kyoto, Japan) in a supine mannequin were observed by indirect vision with a dental mirror (Direct mirror 4P; YDM, Tokyo, Japan), which had a 45° angle between it and its handle. The proper access into cavities was prepared in both molars, and 1-mm diameter circles were marked in ink on the bottom of the cavity preparations simulating the orifices of the mesial and distal buccal roots. The occlusal plane of tooth no. 3 was set perpendicular to the floor for maxillary measurement, and the occlusal plane of tooth no. 30 was set at 45° to the floor surface for mandibular measurement. A rubber dam was applied in each setup.

The operators were categorized into 3 groups according to height: group S (155 cm = 61.0 in), group M (168 cm = 66.1 in), and group T (181 cm = 71.2 in); and each group consisted of 3 operators. We asked the operators to adopt a balanced work posture at a 12 o'clock position, adjusting the height of the operating stool and mannequin head (18). We then examined the suitability of each posture. Operators observed canal orifices holding mirrors in the left hand, and gradually increased magnification from $3.4\times$, $8.5\times$, to $13.6\times$. When both marks on the molar were observed in the mirror simultaneously at a magnification of $13.6\times$, as checked by the monitor image, the DOM observation was considered to have been accomplished. Each operator attempted each observation 3 times. The time taken to obtain magnified images and the

TABLE 1. Measured angles to the floor surface

	Maxillary			Mandibular		
	Binoculars	The body of DOM	Mirror surface	Binoculars	The body of DOM	Mirror surface
Standard setup						
Group S (155 cm)	183.1 ± 4.6 a,b	93.8 ± 2.8	37.8 ± 3.8	182.6 ± 3.9 c,d	91.1 ± 4.7 e	121.7 ± 3.3 g
Group N (168 cm)	172.3 ± 5.5 a	94.2 ± 3.1	40.8 ± 2.3	169.3 ± 5.9 d	87.3 ± 2.6 f	117.2 ± 5.3
Group T (181 cm)	169.0 ± 5.0 b	91.3 ± 4.7	37.6 ± 2.7	165.0 ± 6.2 c	81.1 ± 4.0 e,f	115.3 ± 5.1 g
Group S with options						
Angled optics	188.2 ± 5.8	95.4 ± 3.0	43.6 ± 2.6	189.0 ± 2.4	82.7 ± 2.7	120.1 ± 3.9
Short objective lens	173.0 ± 4.4	88.6 ± 6.1	39.1 ± 5.7	175.7 ± 4.2	87.1 ± 3.2	127.2 ± 5.0

Unit: degree, mean ± (SD), *n* = 3.

The angles were measured to the floor surface using the direction of the patients legs as the starting plane.

Standard setup means the DOM with standard objective lens (250 mm) and without angled optics.

In a standard setup, same letters demonstrate significant difference by Scheff's *F* procedure at a 95% level of confidence.

DOM, dental operating microscope.

angles of the binoculars, the microscope body, and the mirror handle to the floor were all recorded (Fig. 1). The angles of the mirror surface were calculated from the handle to the floor. A level indicator and a circular protractor were used to measure the angles of each part of the DOM to the floor.

The position with a standard setup was less comfortable for the shorter group S operators so the optional devices of angled optics or the short objective lens (200 mm) were used for additional measurements.

Data were statistically analyzed with one-way analysis of variance using Scheffe's *F* procedure as the post-hoc test to compare

TABLE 2. The time needed to obtain the magnified images using a DOM

	Time, s	
	Maxillary	Mandibular
Group S (155 cm)	46.0 ± 16.3	54.1 ± 22.1
Group N (168 cm)	42.6 ± 16.6	45.4 ± 17.7
Group T (181 cm)	62.4 ± 24.7	74.9 ± 32.3

individual means. A *p* value of <0.05 was considered statistically significant.

RESULTS

The angles measured with a standard setup and optional devices are listed in Table 1. Angles were measured using the direction of the patient's legs as the starting plane. Although differences in angles among each group were not remarkable for maxillary tooth observations, significant differences were found in the mandibular tooth observations in group S when using a standard setup. Those operators had to adopt a strained work position for mandibular observation. However, when using both optional devices, the angle of the microscope body was less than 90°, similar to the other 2 groups. Operators felt comfortable in this position for observation.

The times needed to set up the DOM are listed in Table 2. The tallest group T took longer than the others did because one of the operators was inexperienced in using the DOM. Every group took longer to observe mandibular than maxillary teeth.

DISCUSSION

It has been reported that the most common reason for frequently not using a DOM is the difficulty experienced positioning it (14). In this study, we first asked operators to adopt a comfortable appropriate position for their and the patient's chairs. The backs were in a natural position, and the eyepiece was inclined so that the head and neck angle could be sustained comfortably. The operator moved the DOM arm to the operation site for adjustment. It is obviously desirable that operators should not change their posture to conform to the DOM, even though it is assumed that it facilitates an excellent working posture (16).

A wide area of movement of the operator's chair around a patient's chair is possible in most clinical situations. Textbooks

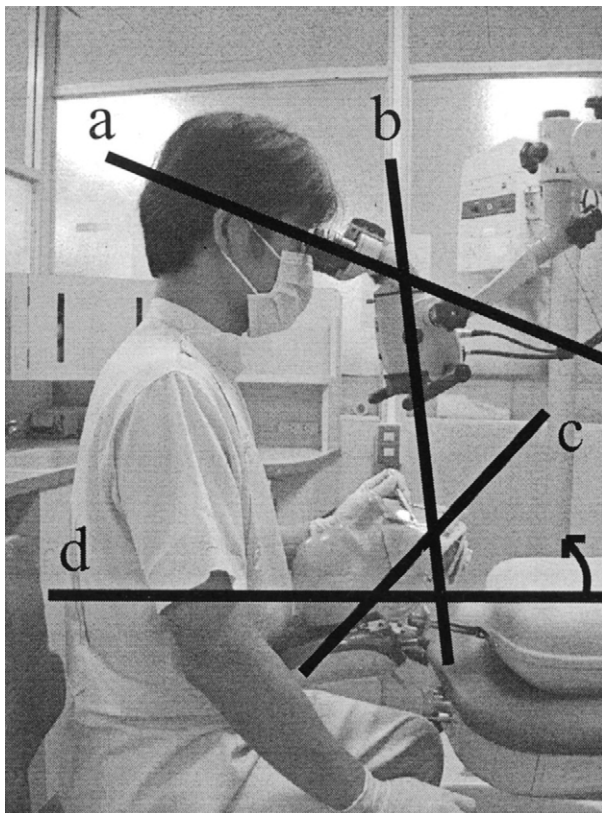


FIG 1. The lines used to measure the angles are shown. The angles of the binoculars (a), the microscope body (b), and the mirror surface (c) to the floor surface (d) were measured using the direction of the patient's legs as the starting plane.

show that the ideal operator zones are in the 7 to 12 o'clock positions for right-handed operators, and 5 to 12 o'clock for left (18). Operators develop their own habits in dental practice to maximize the effectiveness of their dental services to any area of the mouth. In this study, operators worked from the 12 o'clock position, suitable for those both right- and left-handed, where they did not have to change position frequently.

There were no differences between data of angles in groups M and T. Although no operators taller than 181 cm were studied, it is likely that they could adjust the DOM by fixing the binoculars upward. Speculation from the preliminary study suggested that operators taller than 160 cm could easily learn the proper positioning of the DOM by having an understanding of the definitive angles.

However, operators in group S had difficulty positioning the DOM for mandibular teeth. The reasons were that the occlusal surface of mandibular teeth faced the operator and the mirror has to face the direction of the patient's leg. Therefore, the angle of the microscope body should be less than 90°. In this position, the binoculars are further away from the operator's eye; and although tall operators can adjust their posture by slightly bending their wrist, shorter operators could not because of their short upper bodies and the patients' heads being in the way. If shorter operators used the DOM with the angle of the microscope body more than 90° for mandibular observation, it was difficult to see the mesial and distal walls in the mirror simultaneously. Consequently, shorter operators have to lean over the patient's head to obtain the aimed view. Such a strained position seemed hardly comfortable for both operators and patients. Because all groups took longer to observe mandibular teeth, it could be assumed that it is harder to position the DOM for mandibular teeth than for maxillary teeth.

With the optional devices, operators in group S could manipulate the DOM more easily. With the angled optics, the distance between the end of the binoculars and the microscope body is further than that with a standard setup so that operators did not have to lean over the patient's head. However, the increased volume and weight of the DOM created a top-heavy configuration, and made the handling of DOM more difficult than that of the standard setup. With a short objective lens, the position of the microscope body is lower than the standard, 250-mm, objective lens. Less distance between the objective lens and the working field fits the shorter upper body of short operators and meant they did not have to lean over their patient. However, patients could feel oppressed during treatment and operators might have trouble handling various dental instruments because of the short working distances. However, all operators in group S preferred the short objective lens to the angled optics for ease of handling.

Although one particular DOM, OPMI Pico, was selected for this study, any other DOM could probably be equally well-positioned with the angles shown in this study. Dentists working with a DOM would benefit from understanding the data shown. It is also desir-

able when teaching DOM techniques in continuing education courses or education programs that optimal positioning and technical instructions are included.

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