

## No inflow of impression material into the oropharynx during full mouth bite impression taking confirmed with dental CBCT

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**We used three-dimensional images acquired during impression taking with a dental CBCT to confirm the safety of the prototype full-arch bite impression method. We investigated the position and presence or absence of the flow of the impression material into the pharyngeal region. The subjects were 10 dentulous males with no systemic or stomatognathic abnormalities or problems with ingestion or swallowing. Two methods of impression taking were employed using a conventional tray and a prototype bite impression tray, both with alginate impression material and barium. CT images were acquired of subjects with the tray in the oral cavity. We evaluated flow of the impression material into the oropharynx, and the distance between the impression material and the oropharynx. There was no flow of impression material into the oropharynx with either method in any of the 10 subjects. The distance between the impression material and the oropharynx was less with the conventional method than with the bite impression technique. We concluded that the full mouth bite impression method caused no flow of impression material into the pharynx. (J Osaka Dent Univ 2018 ; 52 : 75-82)**

**Key words : Bite impression ; Dental CBCT ; Aspiration ; Accidental ingestion**

### INTRODUCTION

The bite impression is used to increase the efficiency of preparing prostheses. With this method, maxillomandibular registration and impressions of the abutment teeth and opposing dentition can be acquired simultaneously, allowing for fabrication of restorations with accurate occlusal surface morphology.

Many studies on this impression method using a half-arch bite impression tray have been reported.<sup>1-4</sup> Since the impression can be acquired in a short time, it is less stressful for the patient. Also, less time is needed for occlusal adjustment because the occlusal surface morphology of the restoration more accurately reproduces the intraoral morphology. The bite impression method decreases treatment time and reduces the burden on the patient. It may also be useful for home health care.

However, half-arch bite impression trays are diffi-

cult to use for extensive prosthetic restoration, such as long span fixed and removable partial dentures. We prepared a prototype full-arch bite impression tray capable of taking the impression and occlusal registration of a wide region. We have reported that impressions using this tray do not affect hemodynamics during the procedure,<sup>5</sup> that removable dentures for Eichner's classification B cases can be prepared and clinically applied,<sup>6</sup> and that reproducibility of the occlusal contact region is very good.<sup>7</sup> However, flow of the impression material cannot be visually confirmed during the bite impression because it is performed with the mouth closed. Therefore, it is not possible to monitor accidental ingestion or aspiration of the impression materials.

In this study, to confirm the safety of the prototype full-arch bite impression method, we acquired three-dimensional images during the impression using a dental CBCT, and investigated the position, and presence or absence of the flow of impression

material into the pharyngeal region.

## MATERIALS AND METHODS

### Subjects

The subjects were 10 dentulous males with no systemic or stomatognathic abnormalities, or problems with ingestion or swallowing. The mean age was  $28 \pm 2$  years, and the average number of remaining teeth was 28.4. All subjects were capable of nasal respiration.

### Impression taking

Impressions were taken using two methods: A commercial, disposable plastic full-arch tray (GC, Tokyo, Japan) (conventional method) and a prototype disposable full-arch bite impression tray (Premium Plus, Osaka, Japan) (bite impression method) (Fig. 1). The impression was prepared by mixing an alginate impression material (Aroma Fine Plus set; GC), a barium sulfate formulation (Baltop 120; Kaigen Pharma, Osaka, Japan), and sodium pyrophosphate with distilled water. This was compounded and adjusted so as to be equivalent to a silicone rubber impression material (Softflex®; GC), with regard to flow, consistency, initial curing time, and JIS standards. Each physical property was tested beforehand.

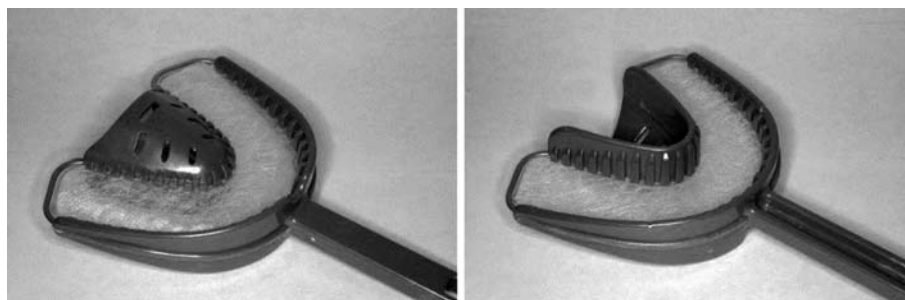
### Acquisition and measurement conditions of CBCT

For the dental CBCT, we used an arm-type X-ray CT diagnostic apparatus (Auge X Zio; Asahi Rentgen, Kyoto, Japan) with a tube voltage of 85 kVp, tube current of 6 mA, a time of 17 seconds and a

range of 104 x 80 mm (A mode). The subjects wore an X-ray protection apron and the minimum necessary acquisition range was set to minimize the exposure. Images were acquired in the 90° sitting position, and the acquisition range was confirmed by scout imaging from two directions. The head and face were fixed using chin and head rests with the midline of the subject's face set vertical, and the Frankfurt horizontal (FH) plane set parallel to the floor. The operator tried the tray into the mouth several times to confirm reproducibility of the mandibular position before the impression was taken. The order of impression taking (conventional or bite impression method) was randomly determined, and CT images were acquired while the tray was in the mouth.

### Measurement items

The acquired imaging data were converted to the DICOM format and input into a personal computer, and the MPR image construction and measurements were performed using VGstudio v. 1.2 (Volume Graphics GmbH, Heidelberg, Germany). We evaluated the presence or absence of flow of impression material into the oropharyngeal region; the distance between the end of the impression material and most anterior lower region of the axis in the median sagittal section; and the distance between the end of the impression material and most anterior region of the axis in the area corresponding to the occlusal plane in the axial section. The oropharynx was defined as the region surrounded by the fauces, posterior wall of the oropharynx, a plane containing the median rearmost



**Fig. 1** Prototype complete-arch bite trays for the maxilla (left) and mandible (right).

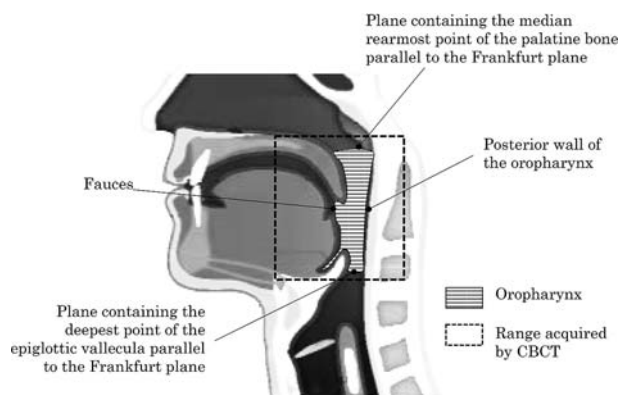


Fig. 2 Oropharynx and range acquired by CBCT.

point of the palatine bone parallel to the Frankfurt plane, and a plane containing the deepest point of the epiglottic vallecula parallel to the Frankfurt plane, according to Molen and Donnelly.<sup>8,9</sup> The range specified by the dotted line in Fig. 2 represents the acquisition range.

We used images where the distance (less than 0.5 mm) between the most posterior region of the palatine bone (posterior nasal spine) and most anterior lower region of the axis in the median sagittal section was essentially the same for the two impression methods. The section in which the metal attached to the margin of the bite impression tray was imaged on the CT was regarded as corresponding to the occlusal plane in the axial section. For the conventional method, the section at the same position was confirmed and regarded as corresponding to the occlusal plane. The images were read and measured by a Japanese dentist certified by the Japanese Prosthodontic Society under guidance of the Department of Dental Radiology.

### Statistical analysis

Using the paired t-test and SPSS Statistics 19.0 (IBM Japan, Tokyo, Japan), we analyzed the distance between the end of the impression material and most anterior lower region of the axis in the median sagittal section, as well as the distance between the end of the impression material and most anterior region of the axis in the region corresponding to the occlusal plane in the axial section for

each impression method. The study protocol was approved as ethically acceptable by the Committee on Experimental Research on Humans of Osaka Dental University (No.110873). The authors have no conflicts of interest.

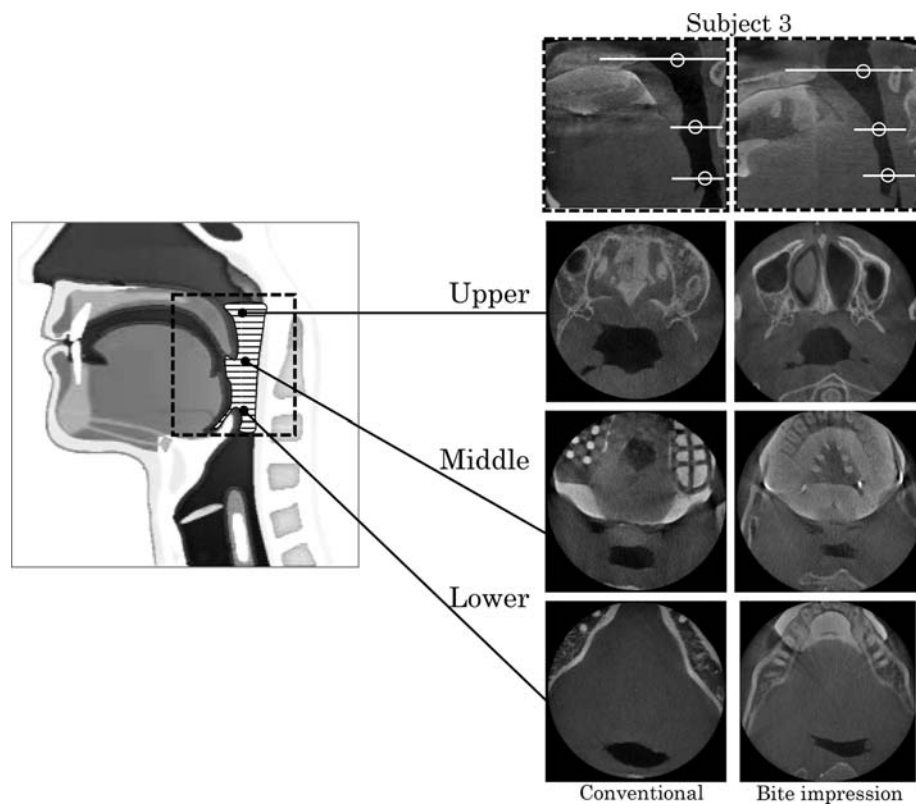
## RESULTS

### Flow of the impression material into the oropharyngeal region

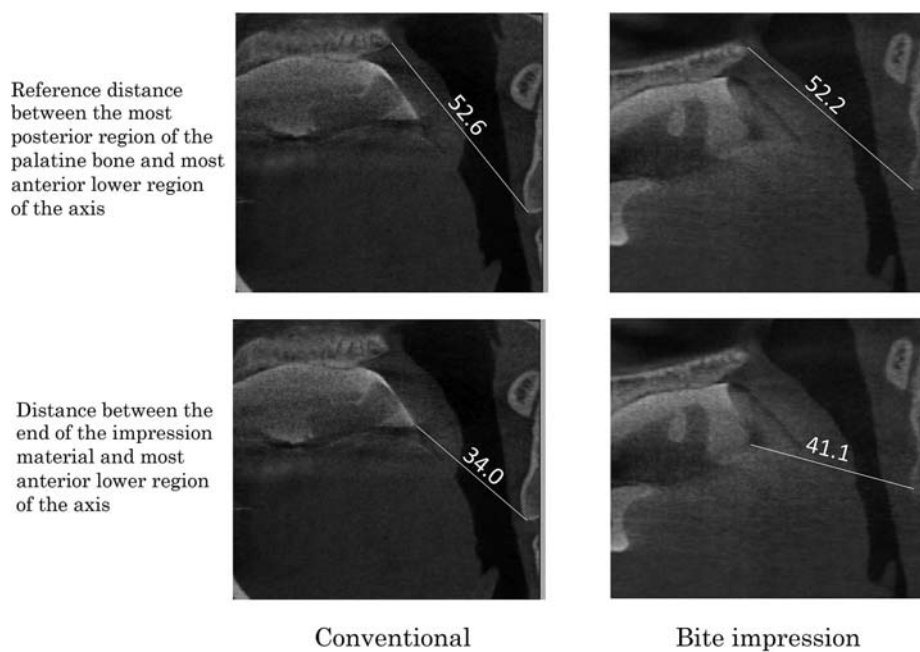
Figure 3 shows an example of a CT image acquired under the measurement conditions. No flow of the impression material was noted into the oropharynx during impression taking in any of the images of the upper, middle, or lower region of the oropharynx in this subject. As well, no flow into the oropharynx occurred in any of the other subjects.

### Distance between the end of the impression material and most anterior lower region of the axis in the median sagittal section

Figure 4 shows an example of the CT images acquired under the measurement conditions. No flow of the impression material was noted into the oropharyngeal region during impression taking employing either the conventional or bite impression method. The reference distance is shown between the most posterior region of the palatine bone (posterior nasal spine) and most anterior lower region of the axis in the median sagittal section. The distance was essentially the same with the bite impression and conventional methods in all subjects. No significant difference was noted, confirming that the reference distance was essentially equivalent (Table 1, Fig. 5). The distance between the end of the impression material and most anterior lower region of the axis in the median sagittal section was less with the conventional than the bite impression method. This tendency was noted in all 10 subjects, and a significant difference was noted between the two impression methods (Table 2, Fig. 6).



**Fig. 3** Flow of the impression material into the oropharyngeal region.

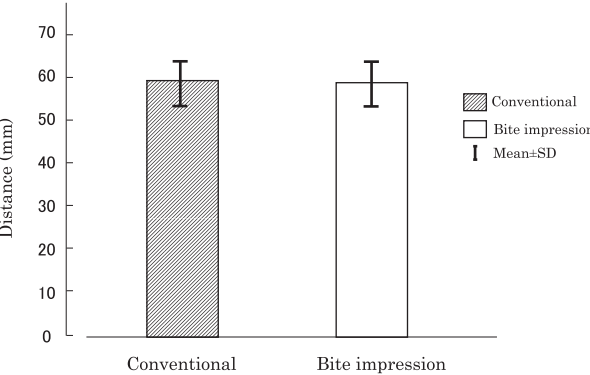


**Fig. 4** Example of the median sagittal section (mm).

**Table 1** Reference distance between the most posterior region of the palatine bone (posterior nasal spine) and most anterior lower region of the axis in the median sagittal section

Subject	Conventional	Bite impression
1	52.6	52.2
2	56.1	56.1
3	61.5	61.6
4	69.9	69.9
5	54.3	54.3
6	57.6	57.8
7	67.6	67.2
8	57.2	57.7
9	47.5	47.7
10	68.8	68.8

(mm)

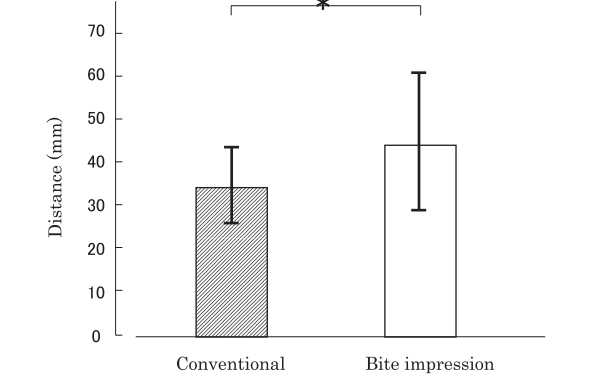


**Fig. 5** The reference distance between the most posterior region of the palatine bone (posterior nasal spine) and the most anterior lower region of the axis in the median sagittal section (n=10).

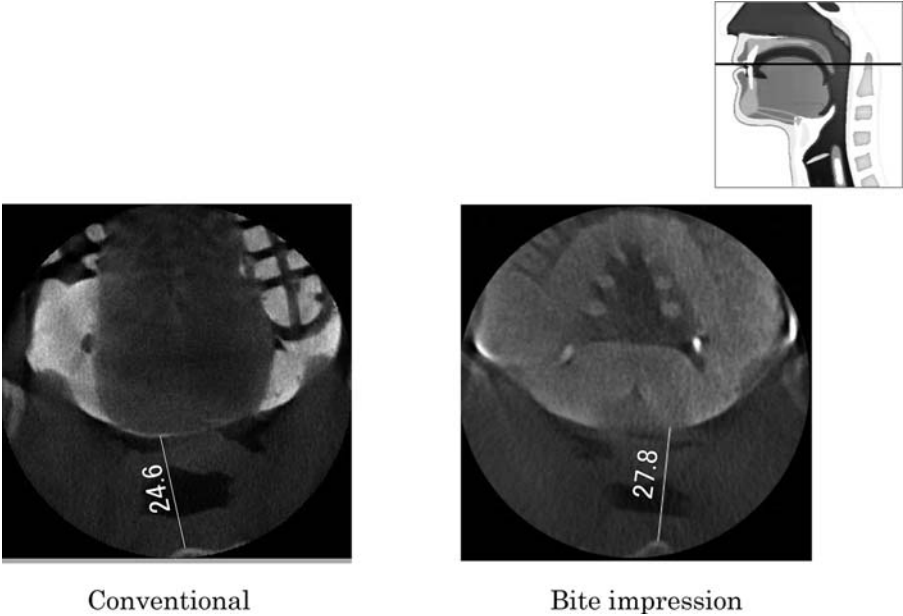
**Table 2** Distance between the end of the impression material and most anterior lower region of the axis in the median sagittal section

Subject	Conventional	Bite impression
1	34.0	41.1
2	29.0	29.3
3	32.7	45.0
4	49.8	63.9
5	27.7	30.5
6	40.5	55.9
7	46.6	67.3
8	32.4	34.6
9	15.4	22.0
10	37.6	59.7

(mm)



**Fig. 6** Distance between the end of the impression material and most anterior lower region of the axis in the median sagittal section (\*p<0.01, n=10).



**Fig. 7** Example of distance between the end of the impression material and the most anterior area of the axis in the region corresponding to the occlusal plane in the axial section (mm).

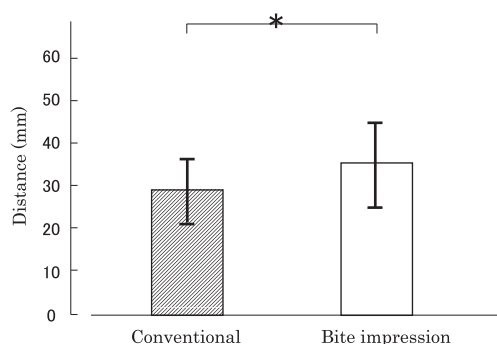
### Distance between the end of the impression material and most anterior region of the axis in the region corresponding to the occlusal plane in the axial section

Figure 7 shows an example of the axial CT images of the region corresponding to the occlusal plane under the measurement conditions. No flow of the impression material was noted into the oropharyngeal region with either the conventional or bite impression method, and the distance between the end of the impression material and most anterior region of the axis was less with the conventional than with the bite impression method. This tendency was observed in all 10 subjects and a significant difference was noted between the two impression methods (Table 3, Fig. 8).

**Table 3** Distance between the end of the impression material and most anterior region of the axis in the region corresponding to the occlusal plane in the axial section

Subject	Conventional	Bite impression
1	24.6	27.8
2	28.6	34.8
3	32.2	34.1
4	38.0	44.0
5	25.5	27.7
6	27.7	44.2
7	47.3	55.7
8	26.9	28.0
9	18.6	21.0
10	22.1	33.9

(mm)



**Fig. 8** Distance between the end of the impression material and most anterior region of the axis in the region corresponding to the occlusal plane in the axial section (\* $p < 0.01$ ,  $n = 10$ ).

## DISCUSSION

### Materials and methods

The subjects were all males. Shibuya *et al.* reported that there are gender differences in the oropharyngeal morphology of the elderly, with the oropharynx being larger in males.<sup>10</sup> The subjects were limited to males to prevent the influence of gender differences.

Only one tray size was used for the two impression methods, which is another reason for limiting the subjects to males. Because silicone rubber impression materials are generally used for the bite impression method, the CBCT was performed using this material in our first tests. However, the contrast of the impression material with the soft and hard tissues was not clear in some slices. This necessitated adjustment of the contrast intensity of the impression material. Therefore, we tried mixing the impression material with a contrast medium for imaging. Contrast media compatible with humans include barium and iodine, both of which interfered with moisture when mixed with silicone rubber, preventing a homogenous mix.

In contrast, alginate impression materials are clear in radiographs because alginate and calcium sulfate are compatible. When we took impressions with alginate in preliminary experiments, the contrast was clearer than with silicone rubber. However, distinguishing it from other tissues was difficult. When alginate was mixed with a barium solution, impermeability increased throughout. We then experimented with preparing an alginate/barium solution mixture with properties close to those of silicone impression materials. These materials were combined with sodium pyrophosphate to produce a flow, consistency, and initial curing time equivalent to that of silicone rubber. The contrast became clearer in CT done using this alginate-based impression material.

The maxillary impressions were done using only the conventional method because the gag reflex is stronger in the maxilla. Ishida *et al.* also stated that maxillary impressions are stressful for patients.<sup>11</sup> Moreover, the amount of the impression material

used in the maxillary portion of the bite impression is almost the same as that used in the maxillary impression with the conventional method. We used three-dimensional CBCT for this study. Although the conditions in the pharynx can be observed by video fluoroscopic examination of swallowing, we did not use this because of the high radiation exposure dose. Impressions were done in the sitting position. Although contrast of the soft and hard tissues may be clearer on multidetector-row CT than with CBCT, the former is generally used in the supine position. Since this would increase the risk of flow into the pharyngeal region, we chose CBCT in the sitting position.

A study with dentulous subjects clarified that the oropharyngeal morphology changes depending on the position of the mandible.<sup>12</sup> To compare changes induced by impressions taken between the open and closed mouth methods, the amount of mouth opening was minimized with the conventional method. By doing this, the mandibular position was similar for the two methods. The flow of impression material toward the oropharyngeal region was observed on the screen. An absence of flow into the oropharynx could be clearly observed because of the contrast enhancement of the impression material. To evaluate the level of the region corresponding to the occlusal plane in the axial section, this level was defined as one quarter of the distance from the center of the base and upper end of the dens of the axis in a previous report.<sup>13</sup> However, since the bite impression represents the occlusal position, and the posterior edge of the tray appears on the CT, we regarded the posterior edge as the position of the occlusal plane. Accordingly, the level was measured in the same region in the images using the conventional method.

## Results

The distance between the extent of the impression material and oropharyngeal region was greater with the bite impression than the conventional method. No flow into the oropharynx was noted. Involvement of the tongue and soft palate were considered when the tray was placed. Furuya *et al.*<sup>14</sup> reported

that the size of the oropharynx differed even with a closed mouth between centric occlusion and with a closed mouth without mandibular fixation. Without occlusion, the root of the tongue, which forms the anterior wall of the lower oropharynx, and the epiglottis, which forms the lower end of the oropharynx, are in tension, increasing the width of the lower oropharynx in the anteroposterior and lateral directions. The dilation of the oropharynx is smaller with occlusion than with only a closed mouth. As a result, the impression material may be less likely to flow into the oropharynx. When an impression is done with the mouth closed, the rear part of the tongue pushes the palatal region upward, and the soft palate and tongue form the wall.

The tongue fits into the prototype tray and the palatal region bulges into an arch. As a result, the tray is designed to prevent imparting pressure on the dorsum of the tongue. This stabilizes the tongue, making the impression material less likely to flow posteriorly. In contrast, when the impression is taken with the mouth open, the impression material that extrudes from the posterior edge of the tray is more likely to flow toward the oropharynx.

Using a dental CBCT, we investigated the three-dimensional state of the pharynx during impressions to confirm the safety of the full-arch bite impression method. We found that the posterior edge of the impression material did not enter the oropharynx. In addition, the distance between the impression material and axis in the median sagittal section was significantly greater when the bite impression method was used than with the conventional method. The impression material was short of the pharyngeal region with the bite impression method in all subjects. In addition, the distance between the impression material and axis in the region corresponding to the occlusal plane in the axial section was significantly greater with the bite impression than with the conventional method. The impression material was far from the pharyngeal region with the bite impression method.

## CONCLUSION

We were able to three-dimensionally observe the

position of the impression material during impression taking with the prototype full-arch bite impression tray by using dental CBCT, and were able to confirm that impression material did not flow into the pharyngeal region.

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