

## Evaluation in Accuracy to Two Impression Techniques: In Case of Bone Anchored Bridge

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### Abstract

**Purpose.** The purpose of this study was to investigate and compare the accuracy of two procedures: open tray with splinting technique and closed tray impression techniques, in innovative *in vitro* experiments.

**Materials and methods.** One master cast was fabricated with 4 abutment replica implants with almost parallel position in anterior region of an edentulous mandibular plaster cast. The working cast was taken impressions with open tray splinting technique (group 1) and closed tray technique (group 2) using polyvinyl siloxane impression material. The Type III dental stone was poured into around the impressions. The accuracy of impression procedures were measured 24 hours later after pouring dental stone to each impression. Four sites were marked to measured on every platform of implant analogs. The analyzing stylus was positioned to each site and the heights, horizontal inclination and saggital inclination were measured using the Laser displacement transducer (LK G115; Keyence, Osaka, Japan). Measurements of these 16 points of four implants per a model was repeated 7 times under the same condition. The gap between the abutment and superstructure at one screw test was evaluated with a digital microscope system (VH-Z100 & VH-5000; Keyence, Osaka, Japan). The mean and standard deviation estimated from the samples of each subgroup were statistically analyzed by ANOVA test ( $P < 0.05$  as the level of significance).

**Results.** The relative differences of implant heights, horizontal inclination and saggital inclination of each implant on closed tray technique was statistically significant different to master cast and open tray with splinting ( $P < 0.005$ ).

**Conclusion.** The open tray technique was more accurate comparing to the closed tray technique. The gap between the abutment and superstructure in the open tray with splinting technique was smaller comparing to closed tray technique.

**Key words:** closed tray, open tray, splinting, accuracy, one screw test

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## INTRODUCTION

Prosthetic dentistry has entered a new era with the successful use of implant. In prosthetic dentistry, taking accurate impressions is of great importance for subsequent successful implant treatment. Since the accuracy of impression affects the accuracy of the master casts, the accurate impression is critical to fabricate a prosthesis with good fit. It is always mentioned that "Passive fit" of the superstructures into the abutment and implant is necessary. An inaccurate impression may result in prosthesis misfit, which may lead mechanical and or biological complications. Mechanical complication includes screw loosening, screw fracture, implant fracture and occlusal unharmony. Biologic complications from overloading above physiologic tolerance levels often result in marginal bone loss and disosseointegration between implant and the surrounding bone. Marginal discrepancy from misfit may biologically cause unfavorable soft and hard tissue reactions due to increased plaque accumulation.<sup>1-5</sup> Even though obtaining absolute passive fit is practically impossible, minimizing the misfit to prevent possible complications is a generally acceptable goal of prosthodontic implant procedure. To achieve a precise, passive fitting of prosthesis, different impression procedures have been suggested in the literature. The results in previous studies are contradictory and confusing. Carr, Daovdi et al. showed that direct method i.e. open tray technique, is

more accurate than indirect method (closed tray technique). The closed tray technique had discrepancies in axial rotation and inclination of analogs.<sup>1,6</sup> Five out of 7 studies published after 2003 recommend open tray technique with the splinting, but some authors did not demonstrate an advantage.<sup>2</sup> Whereas Humphries *et al.* and Herbs *et al.* concluded that the dimensional accuracy was exceptional for all technique. Spector *et al* reported on the potential for distortion when using acrylic resin to splint the impression copings probably as a result of polymerization shrinkage. Conrad *et al.* reported the data that supported acceptance of the null hypothesis as the combined interaction of impression technique, implant angulation and implant number had no effect on accuracy of the master casts compared to the working casts.<sup>1,6,7</sup>

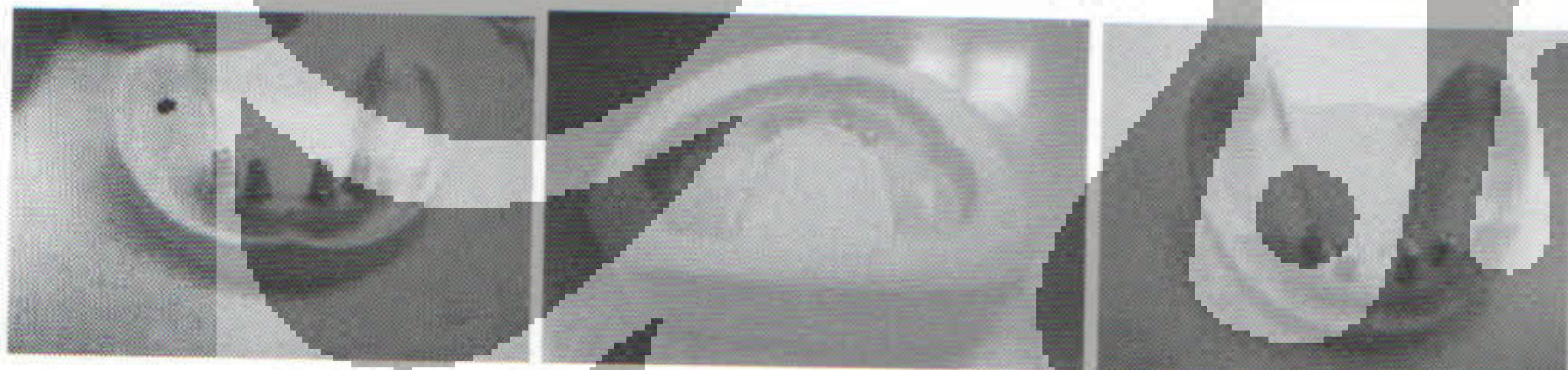
Polyvinlyl silicone impression material was used most frequently in implant dentistry. It has high dimensional stability and it is least affected when poured in delays or by second pouring. It is still accurate even when it is poured 1 week after removal from mouth. It is able to record the tissue detail and in order to make the clinical and laboratory procedures easier.<sup>3,8,9</sup>

The purpose of this study was to investigate and compare the accuracy of two procedures: open tray with splinting technique and closed tray impression techniques, in innovative *in vitro* experiments.

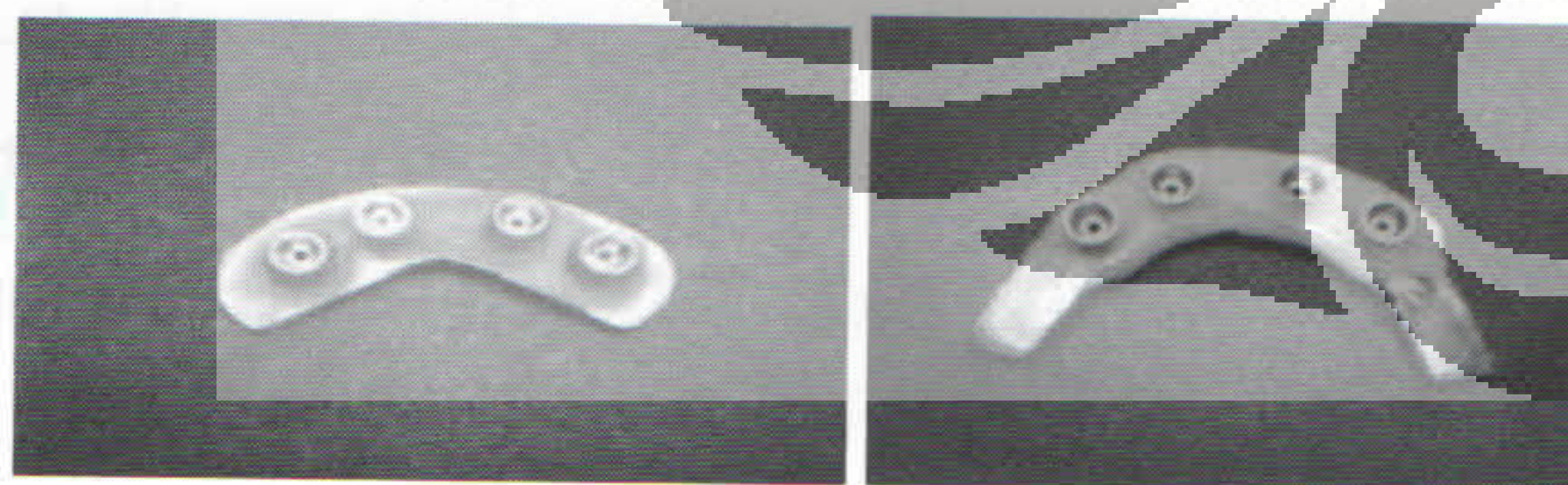
## MATERIALS AND METHODS

### *Experimental models and impression procedures*

Four abutment replica implants were preliminary placed with mutual almost parallel position in anterior region of an edentulous mandibular plaster cast (Fig.1). To create master cast, high quality addition - curing silicon compound (Deguform; German) was used to impress a master model. And then Type III dental stone (New Fuji rock IMP; GC, Japan) as poured to the impression according to manufacture's instruction and the experimental model. In addition the superstructure connected to all implants was fabricated with high stiffness and high passive fit (Fig.2).



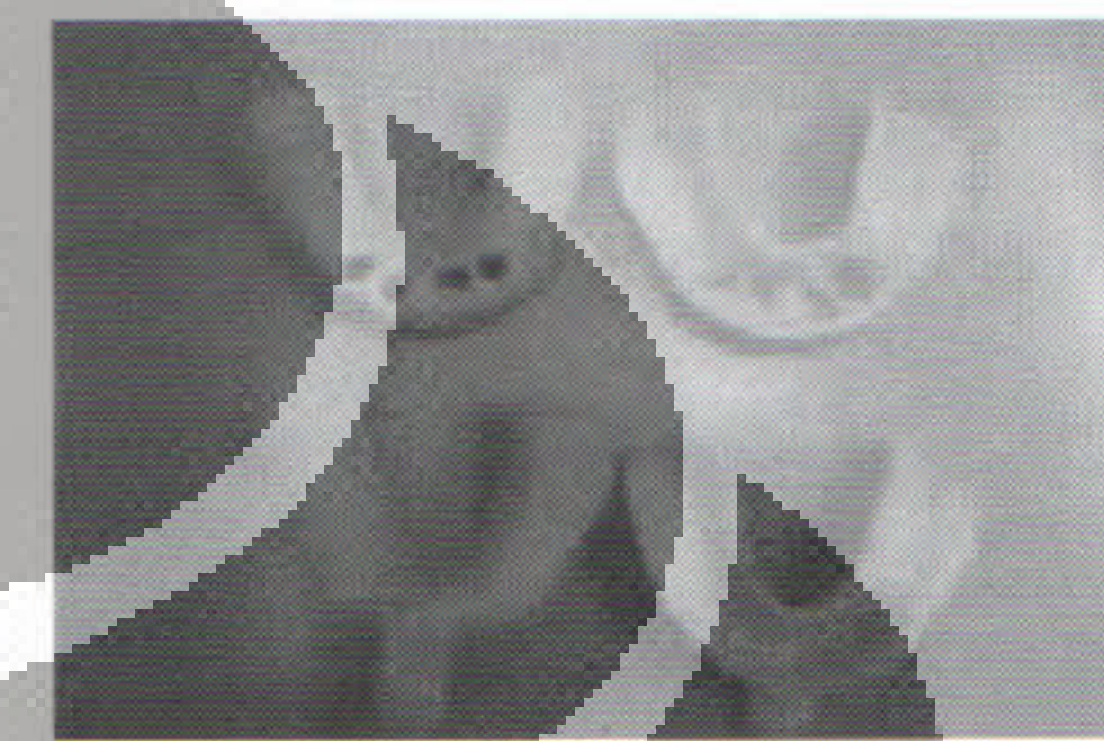
**Figure 1.** Master cast placed four implant analogues with mutual parallel position. Left: preliminary placement of implants, Middle: silicone impression of the left cast, Right: final master model



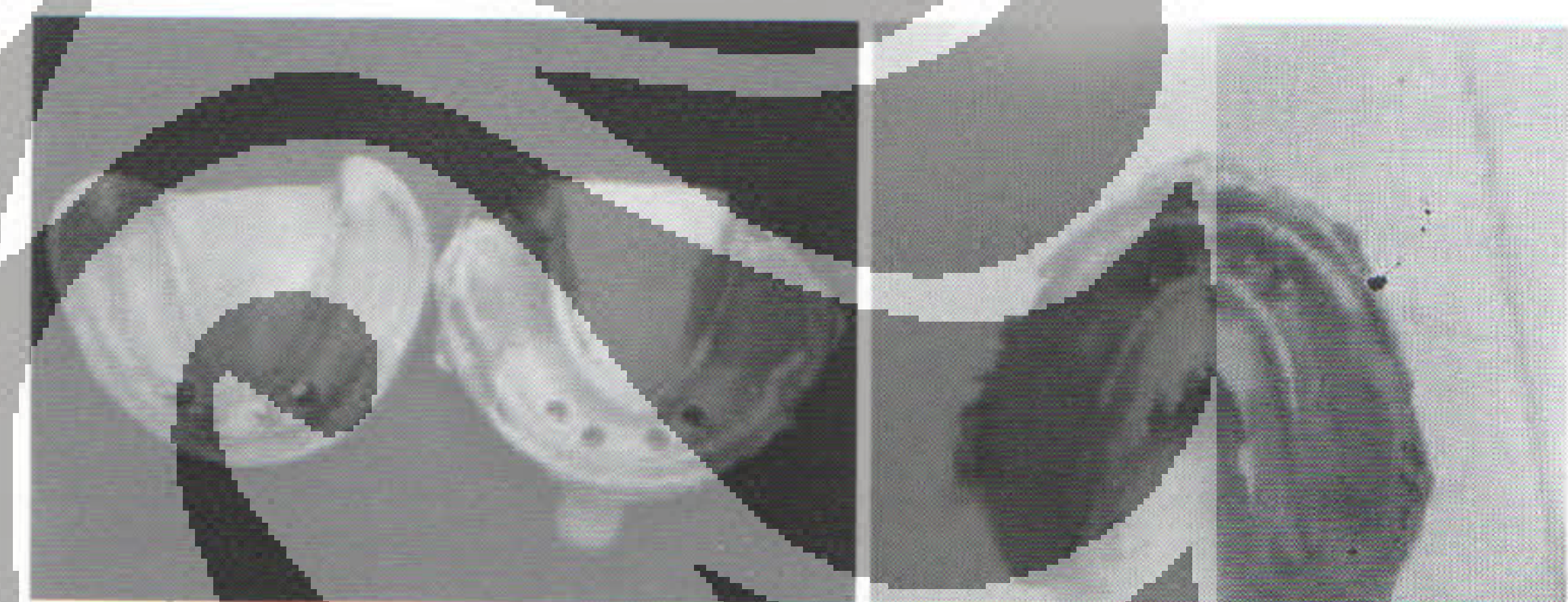
**Figure 2.** The superstructure connected to all implants was fabricated with high stiffness and high passive fit .

Two impression techniques were examined: open tray technique and closed tray impression technique.

As for closed tray impression technique, closed tray impression copings were attached to implant analogs in the master model. Custom impression trays for closed tray impression technique were fabricated using auto-curing acrylic resin (Shofu Inc ) so that the overall thickness of impression material is 3 mm after the impression (Fig. 3, 4).

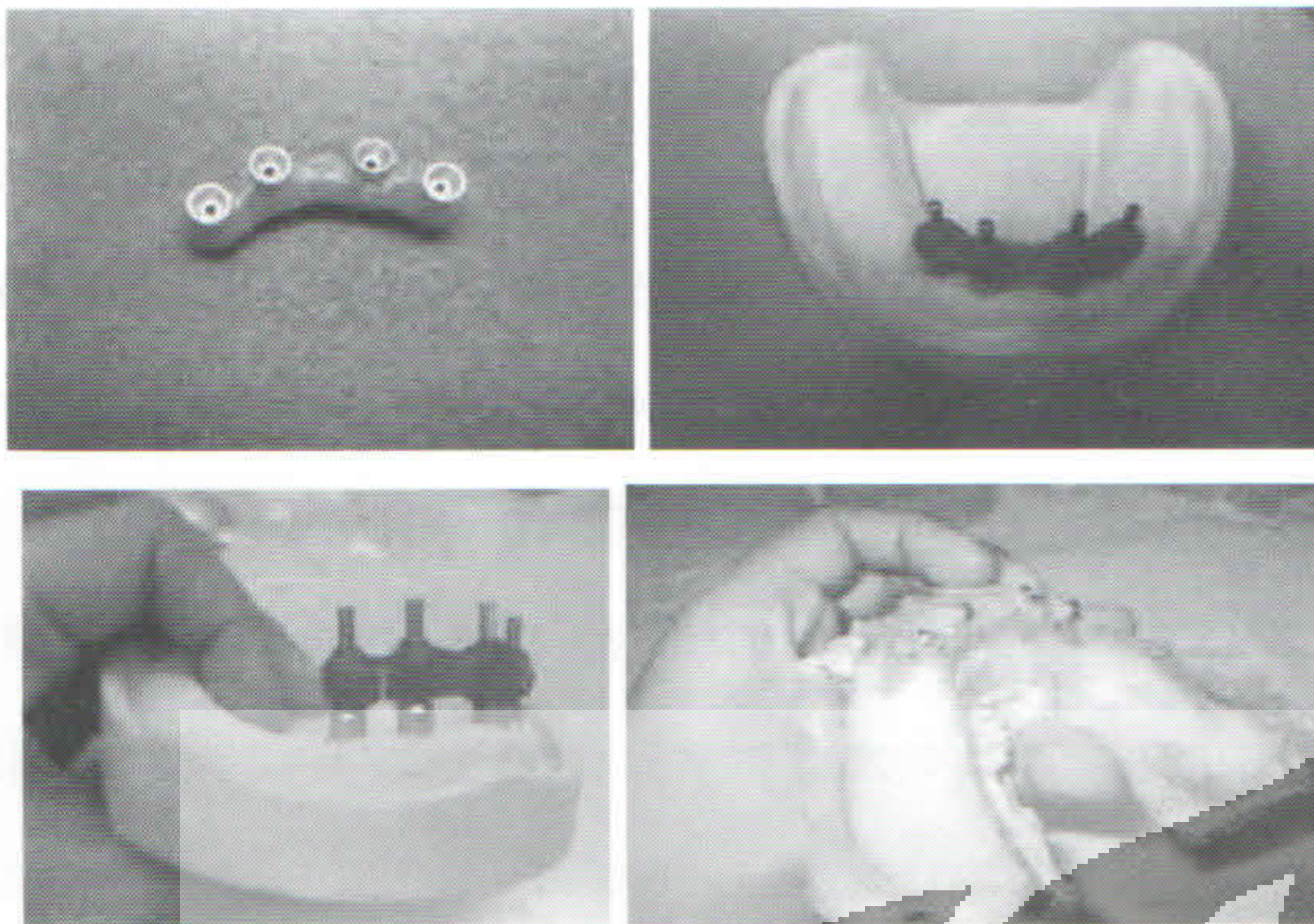


**Figure 3.** Open tray (upper) and Closed tray (lower)



**Figure 4.** Closed tray technique

As for open tray impression technique, impression copings for open tray were connected with auto-curing resin (Acrylic resin for pattern, GC corporation, Japan) of about 2 mm in thickness around four analog implants in master casts. After that, the splinting between implant analog was cut off to release deformation. The new pattern resin was applied on the surface of cut section and wait for 20 minutes (Fig. 5). Custom impression trays were fabricated using shelf curing acrylic resin (Shofu Inc) with 1.5 mm space to impression material for open impression tray



**Figure 5.** Splinting of impression assemblies and open tray technique

The custom trays were painted with vinyl polysiloxane adhesive (VPS tray adhesive; Flammable, GC corporation, Japan) and allowed dry for 15 minutes. Before taking impression, a thin layer of Vaseline (petroleum jelly) was applied into the master cast. The custom tray were filled with heavy body vinyl polysiloxane impression material while light body vinyl polysiloxane (Imprint II Garant; 3M ESPE, St. Paul, Minn) was syringed around the impression copings and marginal area carefully on the master cast. The custom tray was seated on the master cast. In the closed tray the tray was removed at the burst. In the open tray any excess material from the open tray windows was removed with a finger swipe to expose the guide pins. The impression material was allowed to polymerize for 20 minutes (depending on temperature).

For the closed tray technique, the impression copings in the master cast were removed, and then the impression copings were attached with abutment replica implants and placed back into the impression and pushed firmly

(figure 4). Before abutment replica implants was installed into the impression, it must be checked, there was not damage of the platform of analog implant with a microscope (610 XT INOE Attachment, Japan) which has 0.8x magnification. The impression were boxed and filled to form a base height of 10 mm with using vinyl polysiloxane (Exafine putty type; GC corporation, Japan).

For the open tray with splinting technique, the guide pins were removed with a hex driver, the custom tray was removed from the master cast (guide pins and impression copings remains in the impression), and then analog implants were installed in impression and the guide pins were tightened with a hex driver.

All components were made sure properly oriented and completely seated before pouring dental stone. Impression were inspected and repeated when any inaccuracies were found such as air voids, impression material separation from the custom tray or non homogenous mix of 2 viscosities of impression material. The Type III dental stone with the linear setting expansion after 2 days was 0,06 % (New Fuji rock IMP; GC, Japan) was prepared according to manufacturer's instructions. Dental stone was mixed for 45 seconds with vacuum mechanical mixer and vibrator and poured into around analog implant with brush and poured the dental stone fully. Working casts were separated from the impression after allowing the stone to set for 45 minutes, followed by trimming and labeling to prepare for measurements. The

impression procedures were repeated 7 times in each condition. Totally 7 models were fabricated each impression procedure.

*Measurement of accuracy using Laser displacement transducer*

The accuracy of impression procedures were evaluated as follows. The positions of implant analogues in working models were measured 24 hours later after pouring dental stone to each impression. Four sites was marked to measured on every platform of working casts. The analyzing stylus was positioned to each site using a microscope (INOE Attachment Japan, 610 XT) and the heights were measured using the Laser displacement transducer (LK G115; Keyence, Osaka, Japan). It has an accuracy  $\pm 0.05\%$  and a resolution  $0.5\ \mu\text{m}$ . Measurements of these 16 points of four implants per a model was repeated 7 times under the same condition (Fig.6,7).

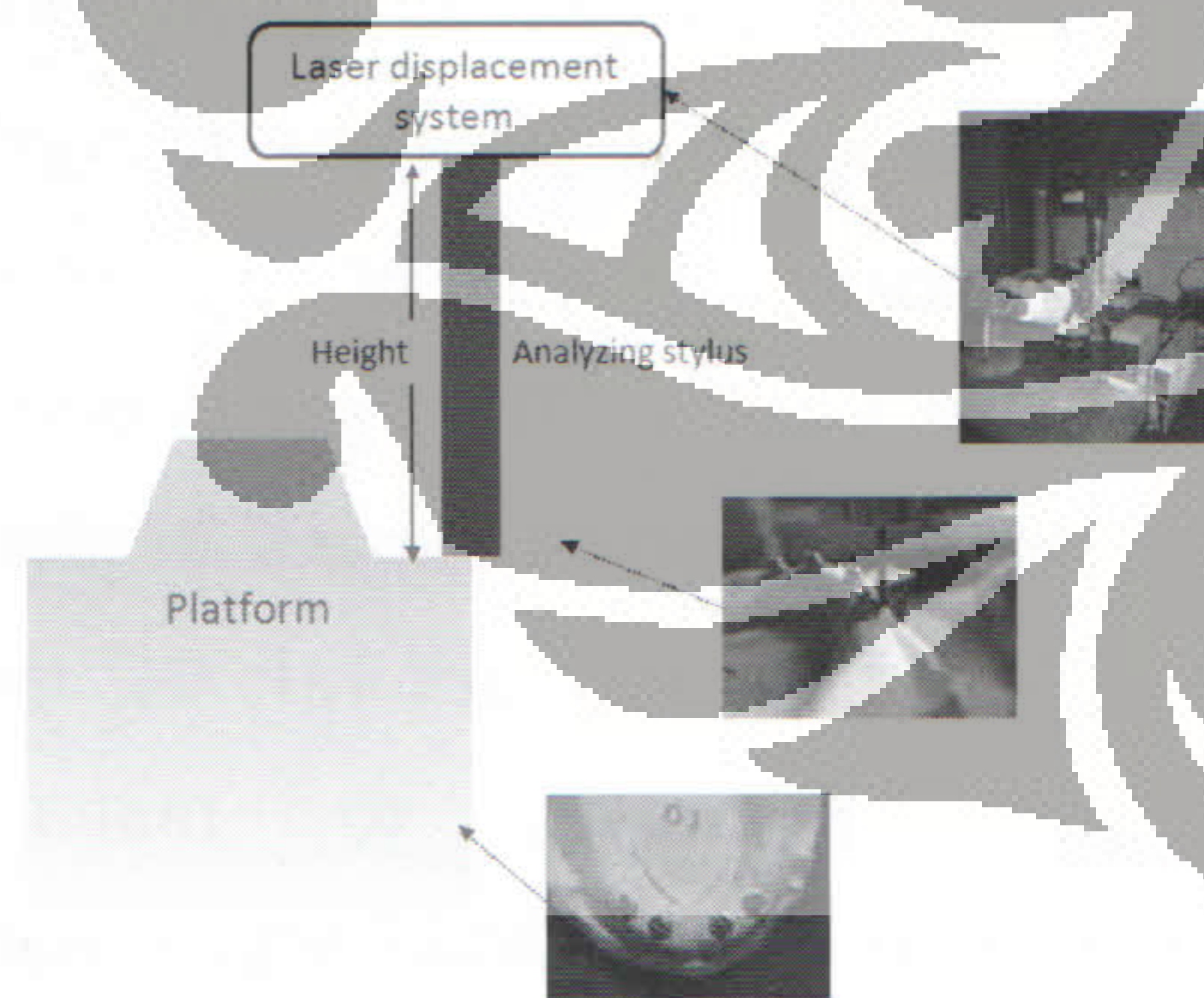


Figure 6. Measurements of heights of four points on every implant platform with laser displacement procedure

The following analyses were done to evaluate the impression accuracy using measurements of 16 points. Firstly, the height of each implant (H1-H4) was defined with the average of four

measured sites on every implant. The impression accuracy was evaluated with mutual differences between adjacent implants ( $D_a$ ,  $D_b$  and  $D_c$ ). Secondly, the horizontal and saggital inclinations of each implant ( $\theta 1- \theta 4$ ,  $\phi 1- \phi 4$ ) were defined as shown in Fig. 7. The impression accuracy was evaluated with mutual differences between adjacent implants ( $H_a$ ,  $H_b$  and  $H_c$ ;  $S_a$ ,  $S_b$  and  $S_c$ ).

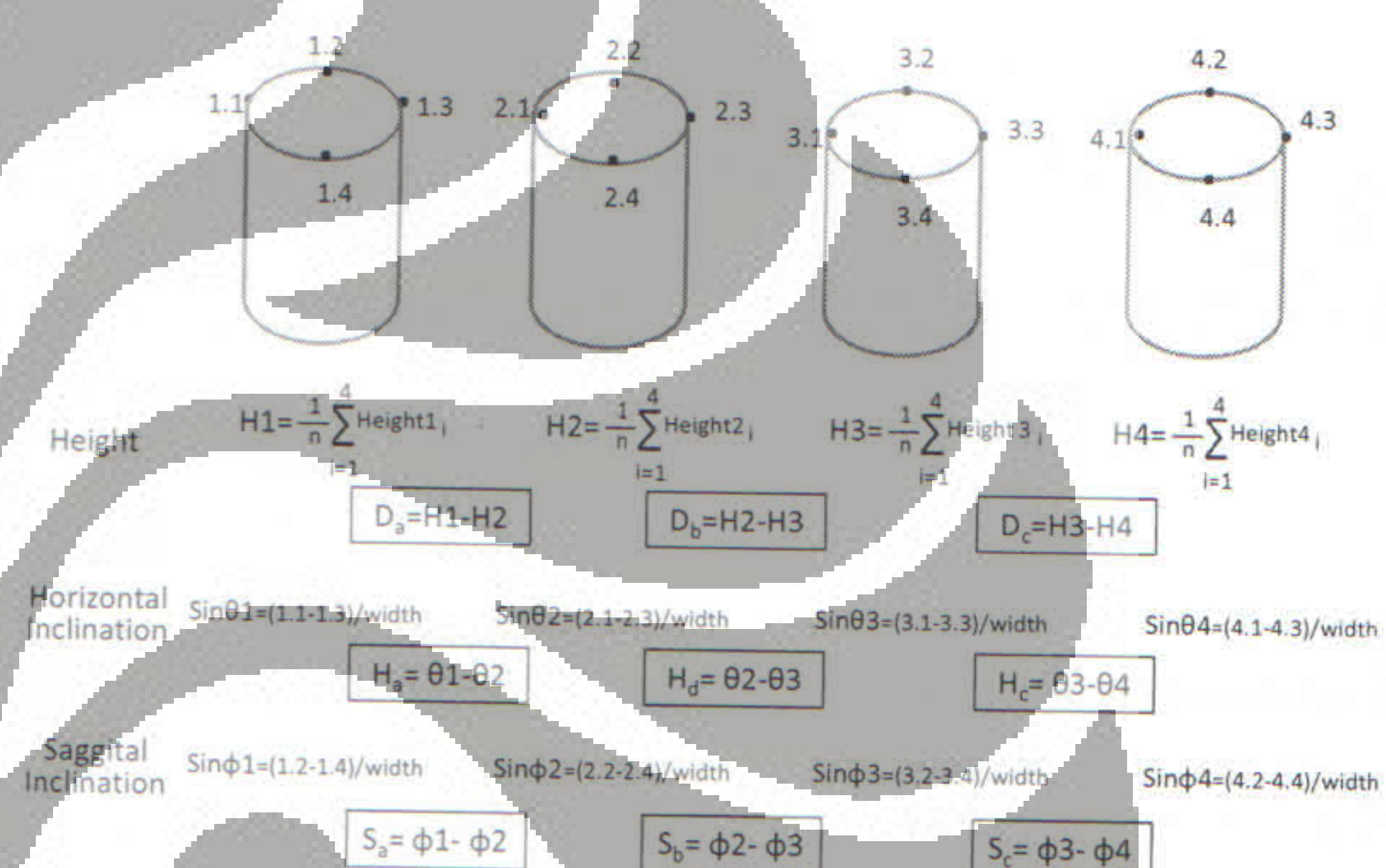


Figure 7. Analyses of measurements on height and inclination

The mean and standard deviation estimated from the samples of each subgroup were statistically analyzed. The differences of heights and inclinations between adjacent implants were statistically analyzed by ANOVA test. In the present study,  $P < 0.05$  was considered as the level of significance.

*Measurement of accuracy using observations with microscope*

On screw test, one of evaluation of superstructure fit, is as follows: when one terminal side of superstructure is screwed to until feeling of resistance, the gap between the abutment and superstructure would be found in the other side. The gap was evaluated with

an digital microscope system (VH-Z100 & VH-5000; Keyence, Osaka, Japan). The working casts was set on the stage of microscope (VH-Z100; Keyence, Osaka, Japan) which set 300x and 400x magnification. The images of gap between abutment and superstructure at one screw test were recorded from buccal and lingual side of each implant. (Fig8).

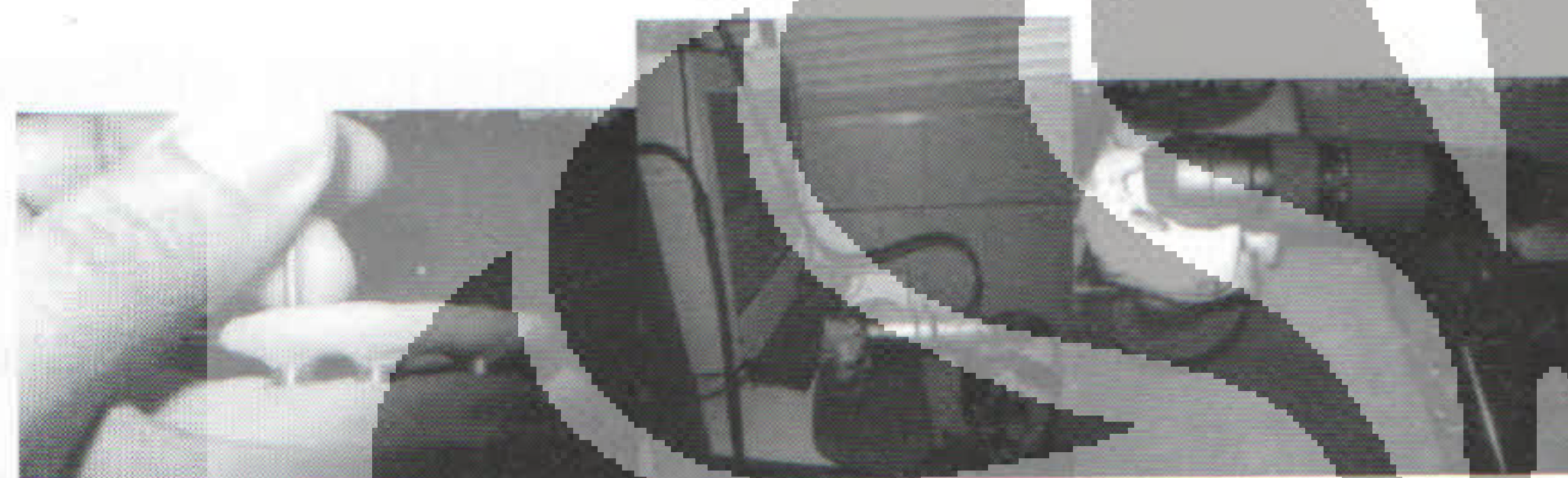


Figure 8. observations of the gap between the superstructure and abutment using a digital microscope. Left: one screw test, Middle: setting of the model examined, C: observations by microscope

**RESULTS**

Figure 9 shows relative differences of implant heights ( $D_a$ ,  $D_b$  and  $D_c$ ) in every technique. Relative differences in the open tray technique was closer to that of in master cast comparing to the closed tray technique.

Figure 10 shows relative differences of horizontal inclinations ( $H_a$ ,  $H_b$  and  $H_c$ ) in every technique. Relative differences of horizontal inclination in open tray technique was closer to that of in master cast comparing to the closed tray technique.

Figure 11 shows relative differences of saggital inclinations ( $S_a$ ,  $S_b$  and  $S_c$ ) in every technique. Relative differences of saggital inclination in open tray technique ( $S_a$  and  $S_c$ ) was almost the same to that of in master cast comparing to

closed tray technique. But relative differences of saggital inclination in  $S_b$  in closed tray technique was closer to that of in master cast comparing to open tray technique.

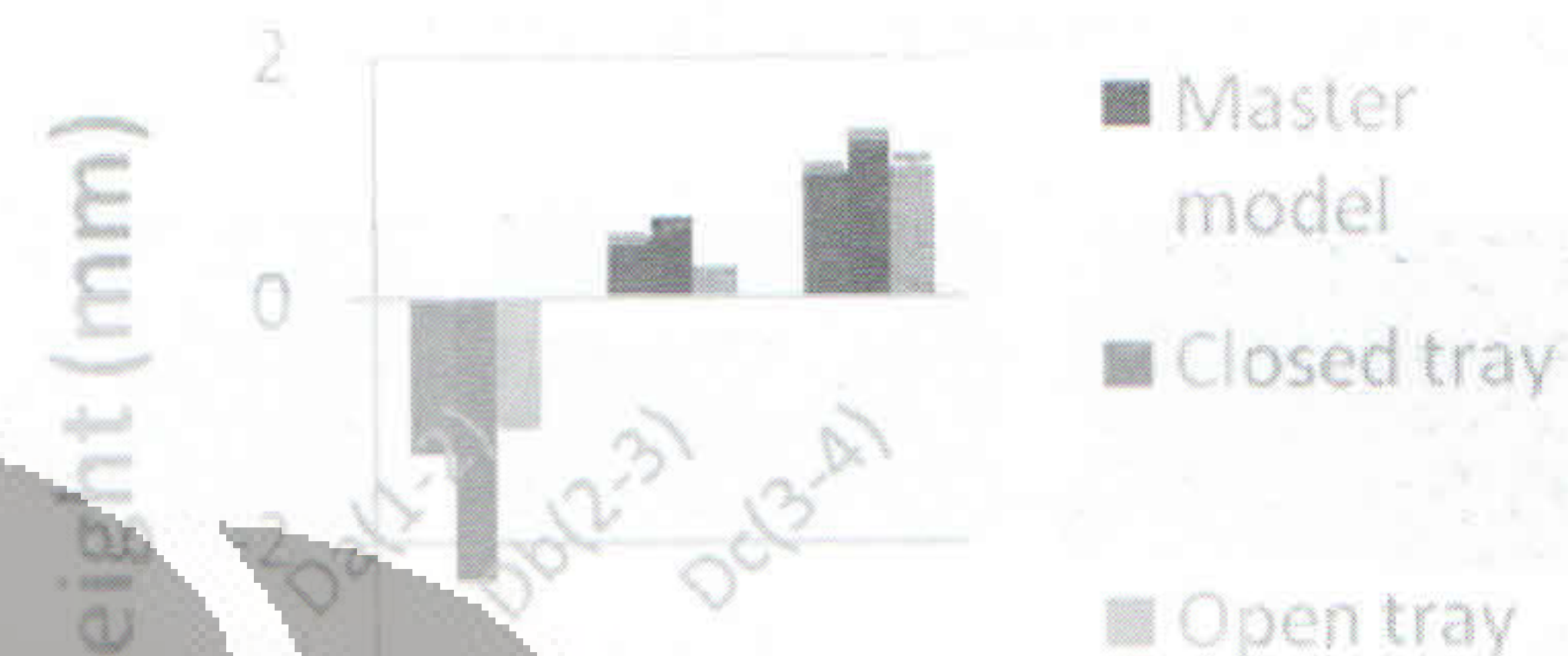


Figure 9. Height difference between adjacent implants

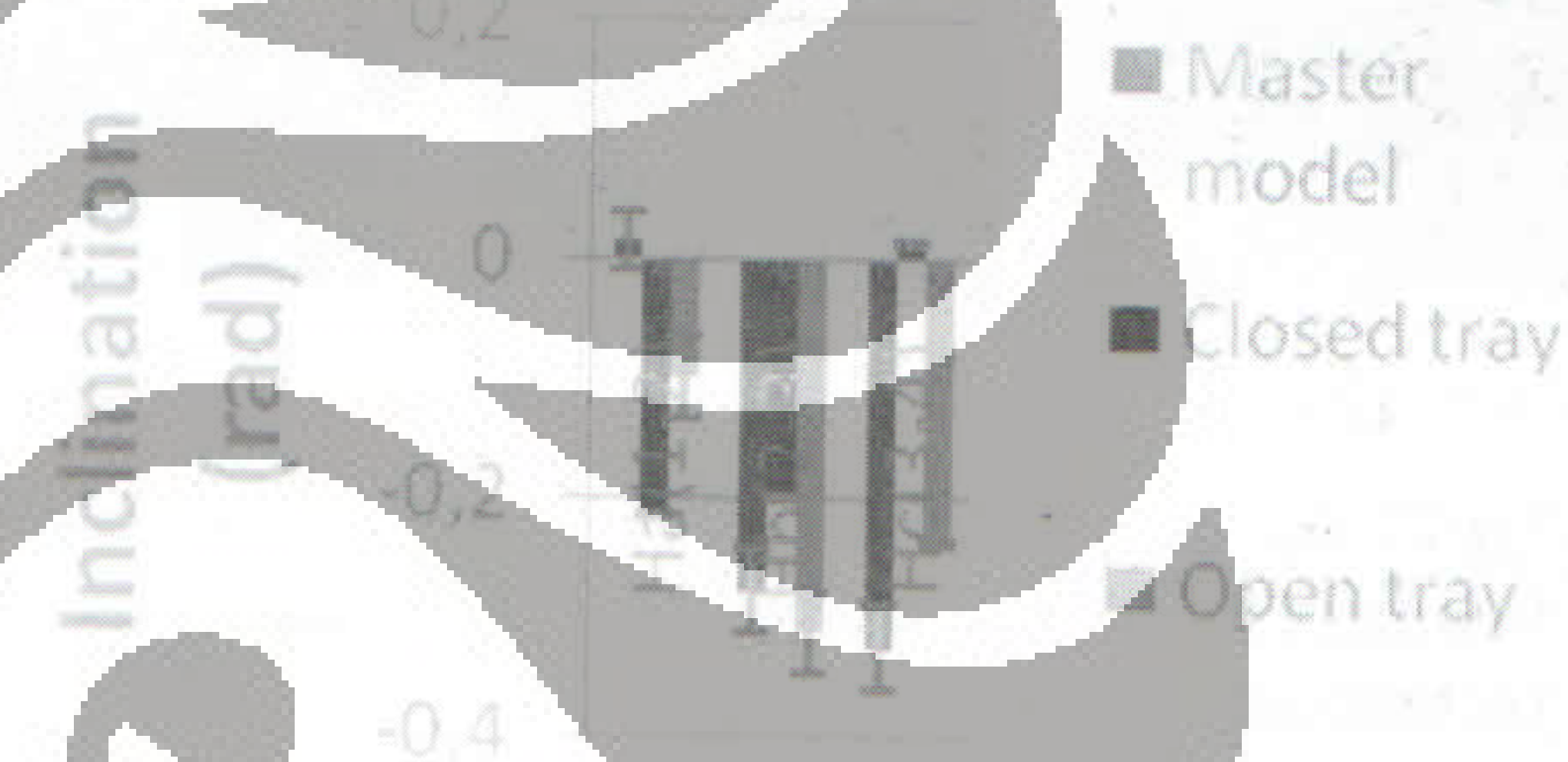


Figure 10. Relative differences of horizontal inclination between adjacent implants



Figure 11. Relative differences of saggital Inclination between adjacent implants

Figures 12 and 13 show microscope observations on screw test in every technique. The gap between abutment implant and superstructure in the open tray technique was smaller comparing to closed tray technique.

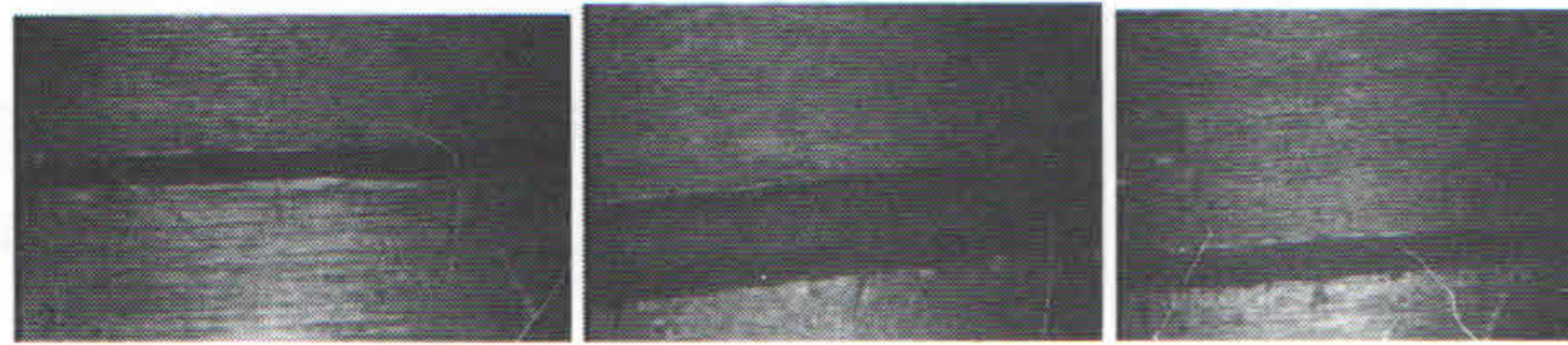


Fig 12. Microscope observation on screw test, Left: master cast, Middle: closed tray technique, Right: open tray technique

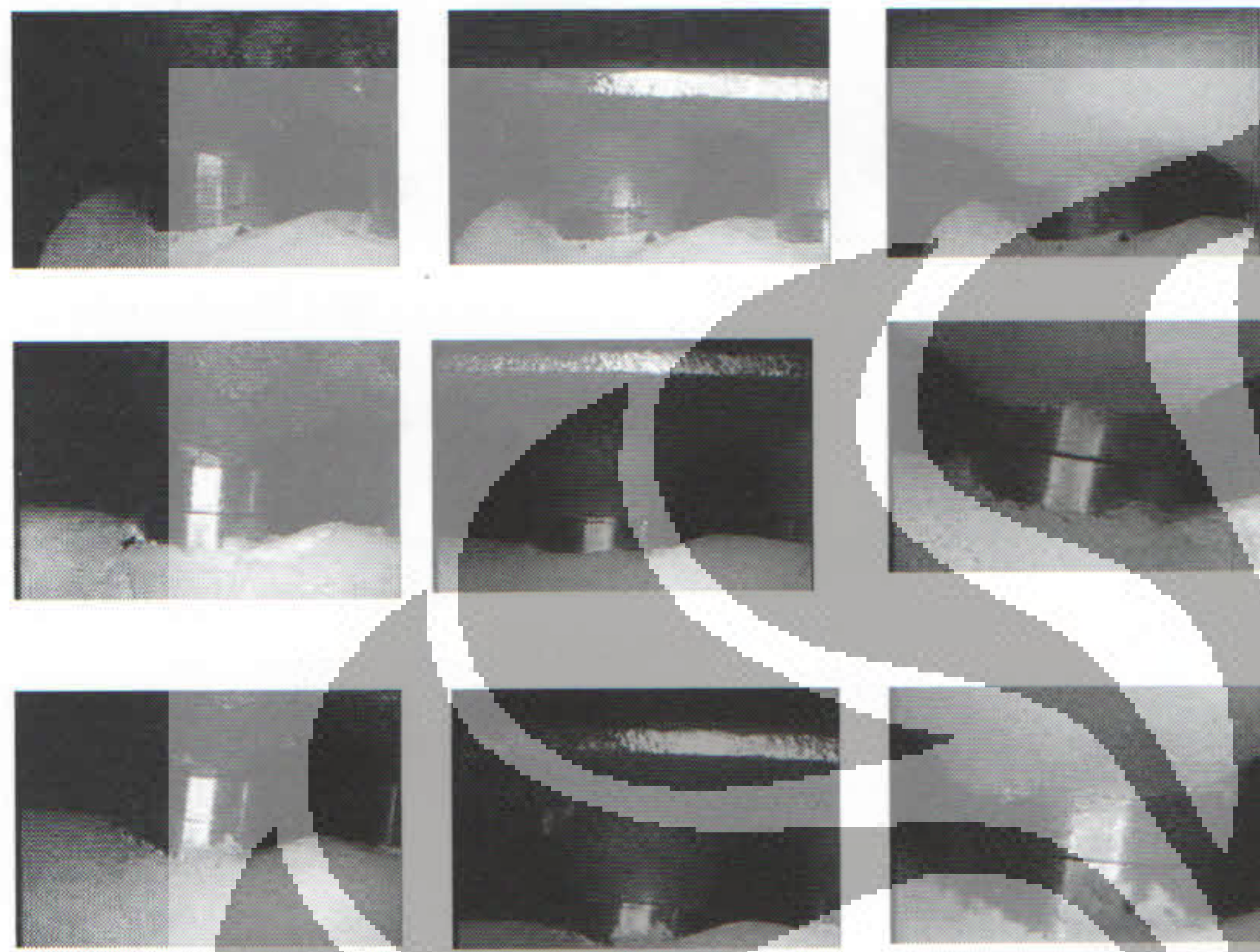


Fig 13. Microscope observation, Upper: Master cast, Middle: Closed tray technique, Lower: open tray technique

Table 1 shows the gap between the abutment and superstructure using microscopic observation on screw test. In the open tray technique, the gap was less than 85 µm and in the closed tray technique, the gap more than 150 µm.

	Implant	Gap of master model	Gap of open tray	Gap of closed tray (µm)
Right side screwed	1	35	84	128
	2	30	85	107
	3	38	42	46
	4*	26	40	43
Left side screwed	1*	25	39	38
	2	35	43	45
	3	28	41	69
	4	45	76	193

Table 1. Size the gap between abutment implant and superstructure from microscope observation. when one terminal of superstructure is screwed (the gap between the abutment and superstructure would be found in the other side). Right side screwed: implant no 4 was tighten, Left side screwed: implant no 1 was tighten

## DISCUSSION

An accurate impression is the most important step to achieve implant-supported prosthesis with properly fitting. The data support that open tray with splinting technique was more accurate comparing to the closed tray technique. The relative differences of implant heights, horizontal inclination and saggital inclination of each implant on closed tray technique was statistically significant different to master cast ( $P < 0.005$ ). Although there was significant different but on relative differences of saggital inclination on  $S_0$ , closed tray technique was more closer to that of in master cast comparing to the open tray technique. Errors may be introduced during any of the several steps required, such as dimensional changes in the material, inaccurate repositioning of impression copings and improper connection of components, flexibility of impression tray, difference in thickness of impression material, setting shrinkage of the material, setting expansion of the material used for making casts, temperature and water powder ration used. All these factors put together could have resulted in the distortion of the resultant cast.

In the present study, two innovative evaluations: digital microscopic observation on one screw test and height measurements of implant platform using Laser displacement transducer, were used to compare the accuracies of two impression techniques. The intraoperator measurement error can be accounted for almost entirely by precision of

measuring stylus (laser displacement measuring stylus) as it may sensitive to detect differences between each implant. There were many factors that can influence the precision of Laser displacement measuring stylus. Laser displacement measuring stylus was sensitive from sound, movement and improper casts placed.

The gap between abutment implant and superstructure in the open tray with splinting technique was smaller comparing to closed tray technique. In the open tray technique with splinting, the gap was less than 85  $\mu\text{m}$  and in the closed tray technique, the gap more than 150  $\mu\text{m}$ . In 1991, Jemt defined passive fit as a level that did not cause any long term clinical complications and suggested misfits smaller than 150  $\mu\text{m}$  were acceptable.<sup>7</sup> Failure to produce a passive fit can result stresses in screw retained prosthesis when the superstructure was connected to the abutment, which may lead complications and mechanical failure.<sup>1,7,10,13</sup>

The open tray technique with splinting allows for impression coping to remain in the impression. It can reduce the effect of implant angulation, the deformation of impression material upon recovery from the mouth and removes the concern for replacing the coping back into respective space in impression. With careful consideration of details the required procedure, because it was potential for distortion caused by polymerization shrinkage when using acrylic resin to splint the impressions copings.<sup>1,11,12</sup>

The result of the present study was not agreement with several studies which reported that the impression accuracy is not dependent on the procedures. Future research is needed to determine the amount of discrepancy tolerable physiology and mechanically, and to clinically analyze failures and complications in implant treatment.

#### CONCLUSION

It is concluded that open tray technique is more accurate comparing to the closed tray technique on the behalf of the following results.

The measurements using Laser displacement transducer suggested that open tray technique was more accurate comparing to the closed tray technique. The relative differences of implant heights, horizontal inclination and saggital inclination of each implant on closed tray technique was statistically significant different to master cast and open tray ( $P < 0.005$ ).

Microscopic observations suggested that the gap between the abutment and superstructure in the open tray with splinting technique was smaller comparing to closed tray technique

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**REFERENCE:**

1. Conrad, Heather, Accuracy of two impression techniques with angulated implant, *J Prosthet Dent* 2007;97:349-356
2. Lee, Heeje, The accuracy of implant impressions; a systemic review, *J Prosthet Dent* 2008;100:291
3. Ozkan, Yasar, Evaluation of the methods used for impression making for different implant systems in prosthetic dentistry, *Cienc Odontol Bras* 2006 abr/jun; 9(2);21-33
4. Lynch, Samuel et al, *Tissue Engineering, Applications in oral and maxillofacial surgery and periodontics*, second editions, Quintessence publishing Inc, 2008;119-132
5. Carranza, *Clinical Periodontology*, tenth edition, Elsevier Inc, 2006; 1072-1182
6. Herbs, Evaluation of impression accuracy for osseointegrated implant supported superstructures, *J Prosthet Dent* 2000;83:555-61
7. Mogi, Mitsuru, Reproducibility of the position for divergently placed implants on a dental model, *Journal of Japanese of oral implantology*, vol 15, no 3, September 2002, 315-22
8. Powers, John, *Dental materials Properties and Manipulation*, Ninth edition, Mosby Inc, 2008; 172-195, 339-345
9. Anusavice, *Phillips's Science and dental Material*, Eleventh edition, Elsevier Inc, 2003; 205-259, 759-778
10. Kan, Joseph, Clinical methods for evaluating implant framework fit, *J Prosthet Dent*, 1999;81
11. Powers, John, *Craig's Restorative Dental material*, Twelfth edition, Mosby Inc, 2006; 555-571
12. O'brien, William, *Dental Material and Their Selection*, Third edition, Quintessence Inc, 2002; 294-310
13. Wilson, Thomas, *Fundamental of Periodontics*, Quintessence publishing Inc, 2003;579-631