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Clinical survey and working time evaluation in guided drilling for preparing a screw hole in implant-supported fixed prosthesis

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Purpose: This study aimed to examine the prosthetic likelihood on the manufacturing and removal methods of implant-supported fixed prostheses and to compare the time taken to form a screw hole in implant-supported cement-retained prostheses according to whether or not a digital drilling guide template is used in the oral cavity.

Materials & Methods: Twenty-five dentists participated in this study. A survey was conducted to assess participants' prosthetic likelihood on the fabrication and removal of implant-supported fixed prostheses. To make the study model, implants were placed in the mandibular molar at 0 and 30 degrees of angulation. Drilling guides for forming a screw hole were fabricated using digital technologies. The conditions were classified into four groups according to implant angulation and use of the guide. Participants prepared a screw hole through the crowns in the dental phantom models, and the working time was recorded. Statistical significance was assessed using the two-way analysis of variance (ANOVA) ($\alpha = 0.05$).

Results: The survey showed that clinicians tend to prefer easy removal and reuse of implant prostheses. The guided drilling required a significantly shorter time in hole formation than the freehand drilling at the 30-degree setting ($P < 0.05$), whereas there were no differences at the 0-degree setting.

Conclusions: The ease of removal and reuse of prostheses are elements of interest in clinic. The use of a drilling guide for locating the abutment screw highly reduces the working time for severely angulated implants. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2021;13(1):23-28)**

Key words: Implant, Fixed prosthesis, Guide template, Survey, Screw hole, Preparation time

INTRODUCTION

The cement-retained implant fixed prostheses use cement to hold the prosthesis to the implant abutment. The cement layer between the prosthesis and the abutment reduces the possibility of mechanical complications due to the misfit between the components and stress concentration[1]. Main advantage of cement retention type is high esthetics and easy formation of the occlusal surface because a screw hole is not present. Meanwhile, when the prosthesis needs to be removed due to biological, mechanical, and esthetic complications in cement-retained implant prostheses, it may be difficult to separate from the abutment. Mechanical sectioning method using cutting burs causes destructive damage to the prosthesis, preventing reuse and damaging the abutment and underlying implant[2].

Forming a screw hole in the oral cavity for the removal of cement-retained implant prostheses is a conservative procedure and can increase the reusability of the prosthesis. However, because it is difficult to accurately estimate the position of the abutment, the hole may be formed in the wrong position. In order to improve the accuracy of the formation of screw access holes in the oral cavity, various visual and physical guidance methods have been introduced. The methods used in the early days were marking the area corresponding to the position of the abutment on the occlusal surface with colored dots[3,4], image taking of the position of the abutment in manufacturing the prosthesis as a digital photograph during the prosthetic treatment process[5], and radiography taking as using apical radiographs or cone-beam computed tomography images[6,7]. A physical method of using a guide template with a simple structure using a vacuum-pressed

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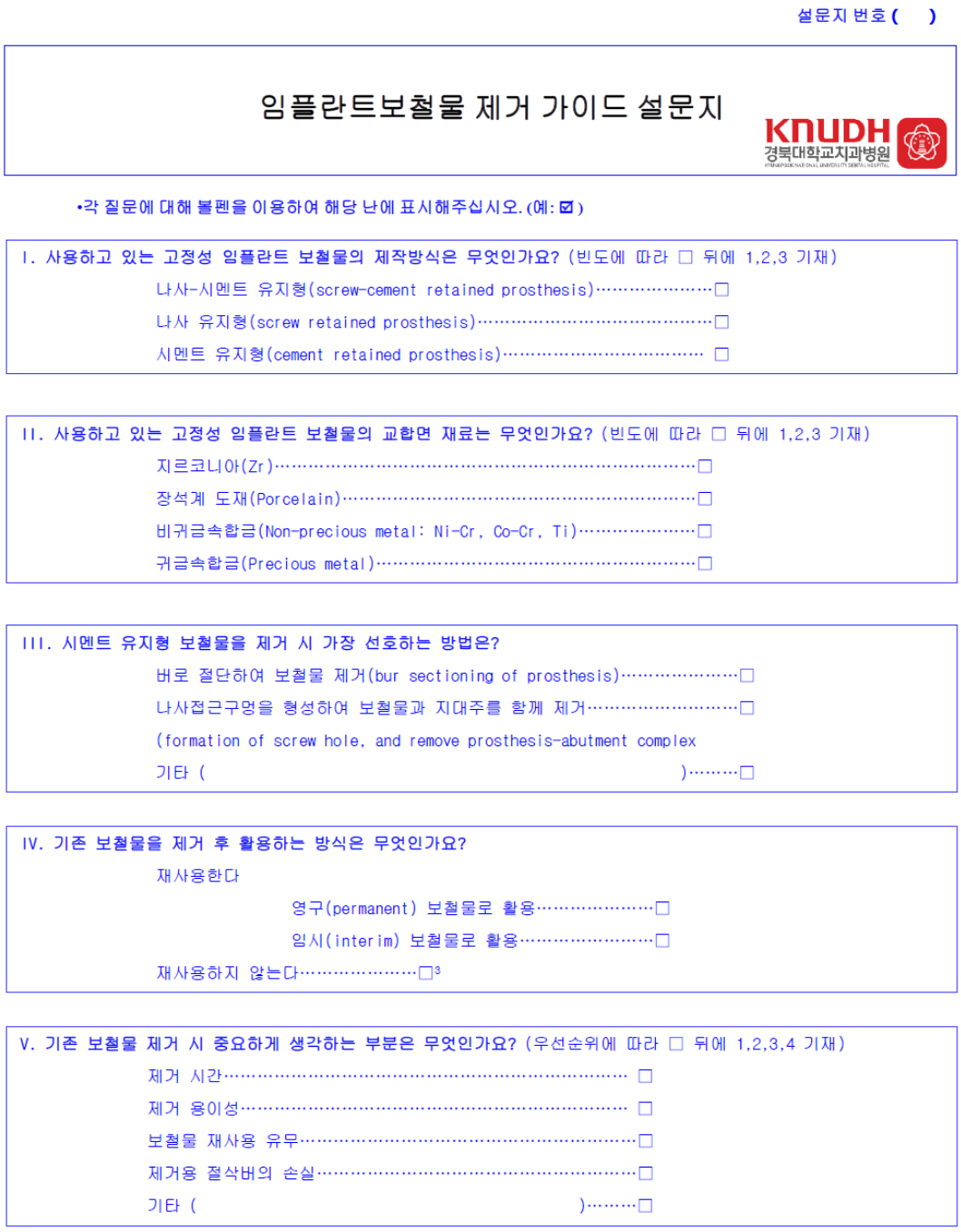
resin plate was also introduced[8].

With the introduction of computer-aided design and computer-aided manufacturing (CAD/CAM) methods into dentistry, digital fabrication of guide templates became possible[9,10]. It has been reported that the use of the guide template significantly improves the accuracy of hole formation[11,12]. Although there have been studies on the accuracy of the hole drilling guide template, the effect of the use of the guide template on the working time required for screw hole formation has not been investigated. The first purpose of this study was to examine the current status of the manufacturing and removal methods of implant-supported fixed prostheses used by dentists in clinical practice. The second purpose of this study was to compare the time taken to form a hole in an implant-supported cement-retained prostheses accord-



설문지 번호 ( )

임플란트보철물 제거 가이드 설문지

KNUDH 경북대학교치과병원

•각 질문에 대해 볼펜을 이용하여 해당 난에 표시해주십시오. (예: ☑)

I. 사용하고 있는 고정성 임플란트 보철물의 제작방식은 무엇인가요? (빈도에 따라 □ 뒤에 1,2,3 기재)

나사-시멘트 유지형(screw-cement retained prosthesis)……□

나사 유지형(screw retained prosthesis)……□

시멘트 유지형(cement retained prosthesis)…… □

II. 사용하고 있는 고정성 임플란트 보철물의 교합면 재료는 무엇인가요? (빈도에 따라 □ 뒤에 1,2,3 기재)

지르코니아(Zr)……□

장석계 도재(Porcelain)……□

비귀금속합금(Non-precious metal: Ni-Cr, Co-Cr, Ti)……□

귀금속합금(Precious metal)……□

III. 시멘트 유지형 보철물을 제거 시 가장 선호하는 방법은?

버로 절단하여 보철물 제거(bur sectioning of prosthesis)……□

나사접근구멍을 형성하여 보철물과 지대주를 함께 제거……□

(formation of screw hole, and remove prosthesis-abutment complex

기타 ( )……□

IV. 기존 보철물을 제거 후 활용하는 방식은 무엇인가요?

재사용한다

영구(permanent) 보철물로 활용……□

임시(interim) 보철물로 활용……□

재사용하지 않는다……□3

V. 기존 보철물 제거 시 중요하게 생각하는 부분은 무엇인가요? (우선순위에 따라 □ 뒤에 1,2,3,4 기재)

제거 시간…… □

제거 용이성…… □

보철물 재사용 유무……□

제거용 절삭버의 손실……□

기타 ( )……□

Figure 1. Questionnaire for assessing participants' prosthetic likelihood.

ing to whether or not a digital guide template is used when forming a screw hole in the oral cavity.

MATERIALS AND METHODS

1. Participant recruitment and questionnaire survey

Twenty-five dentists were recruited who had a similar educational background and practical training. To assess participants' prosthetic likelihood on implant-supported fixed prostheses, a survey was conducted. The survey comprised five questions assessing types of implant prosthesis used, prosthesis removal methods, and preference for reuse of removed prosthesis (Figure 1). Dentists were asked to respond to the questions according to frequency and their priority. Ethical approval for the study was granted by the institutional review board of Kyungpook National University Dental Hospital (KNUDH-2019-12-01-01).

2. Study model preparation and working time measurement for screw hole formation

Two partial edentulous mandibular stone models with the second molar missing were prepared. An implant with 4.5 mm in diameter and 10.0 mm in height (AnyOne, MegaGen, Daegu, Korea) was placed at angles of 0 or 30 degrees (Figure 2A). Then, a prefabricated prosthetic abutment (Anyone abutment, MegaGen) was connected to the implant, and digitized by using an intraoral scanner (CS3600, Carestream, Rochester, NY, USA). Definitive zirconia crowns (N = 50) were fabricated by using a CAD/CAM method (IDC D1, Amann Girrbach, Koblach, Austria; NextDent 3100, Prettau, Zirkonzhan, Bruneck, Italy) (Figure 2B).

The experimental groups were divided into four conditions based on the implant placement angles and the use of the drilling guide: 0-degree implant, freehand drilling (0F); 0-degree implant, guided drilling (0G); 30 degrees tilted implant angle, freehand drilling (30F), 30 degrees tilted implant, guided drilling (30G). The screw-hole drilling guides were made by using digital fabrication technologies (Figure 3)[9,10]. The fabricated study casts were positioned in the phantom heads (PH-1-DK, Shinhung, Seoul, Korea), and the dentists were directed to form a screw hole on the implant-supported cement-retained restoration in the mandibular molar region. The hole preparation was performed first using end-cutting burs (FG #330, Komet Dental, Lemgo, Germany; Diamond point FG #265R, Shofu, Kyoto, Japan), and widened using a torpedo bur (CR-26F, Mani, Tochigi, Japan). When the drilling was completed, the abutment screw was loosened and the prosthesis-abutment complex was collected.

3. Statistical analysis

The means and standard deviations of the working time were calculated. Statistical comparisons among groups were performed by using the analysis of variance (ANOVA). All statistical analyses were carried out using statistical software SPSS (IBM SPSS Statistics v25.0, IBM, Armonk, NY, USA) at a 0.05 significance level.

RESULTS

The results of the survey are shown in Figure 4. In prosthesis fabrication, the screw-cement retention type is used the most in

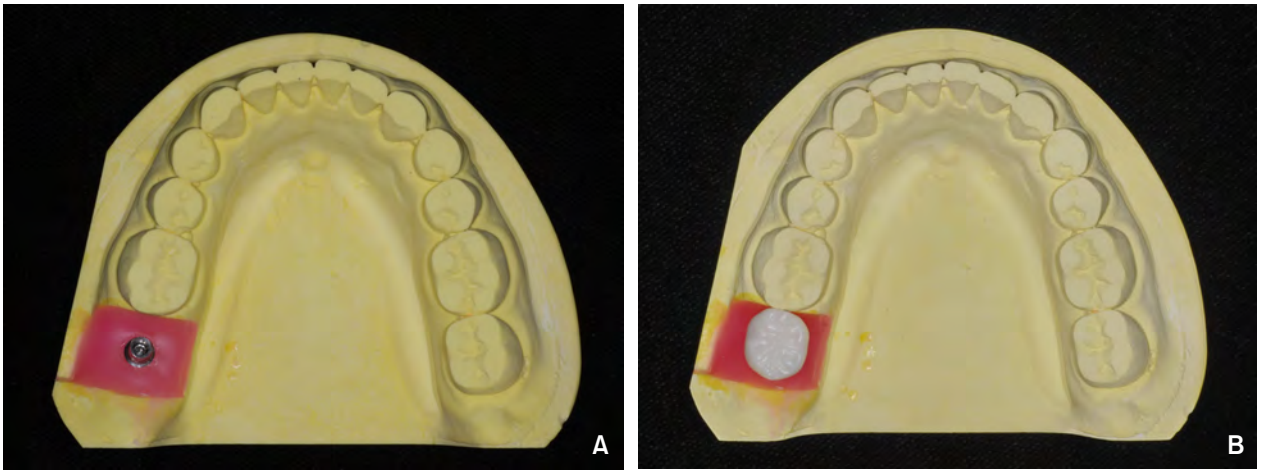


Figure 2. Study model fabrication. (A) Implant placement, (B) Zirconia crown delivery.

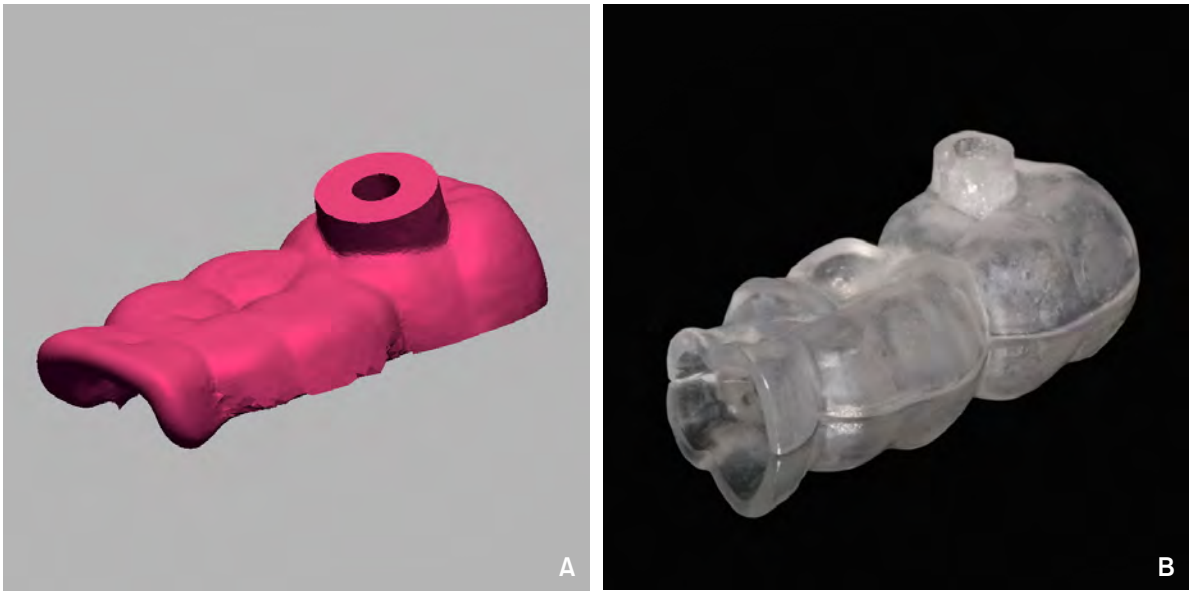


Figure 3. Screw–hole drilling guide. (A) Computer–aided design. (B) 3D–printed guide template.

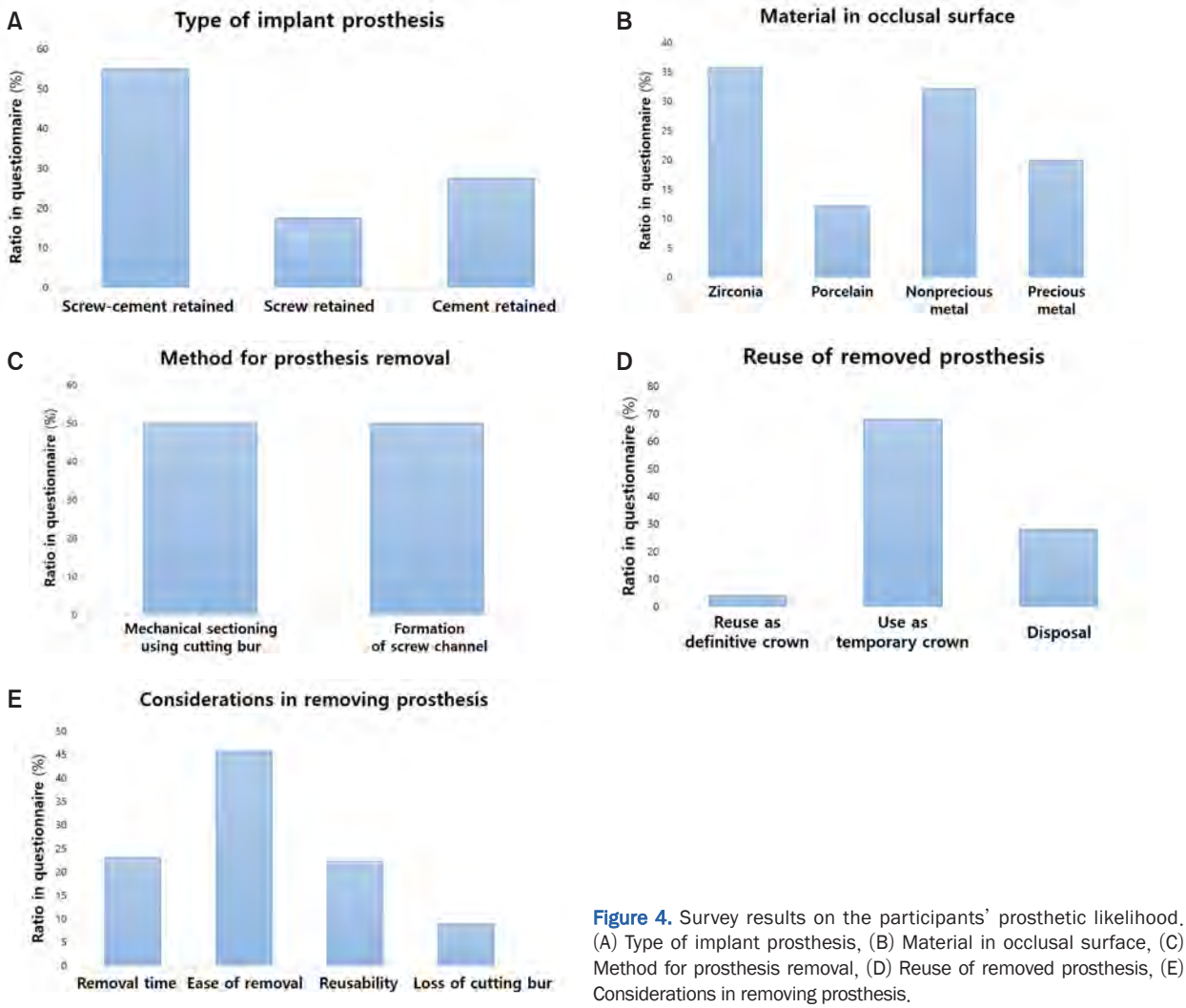


Figure 4. Survey results on the participants' prosthetic likelihood. (A) Type of implant prosthesis, (B) Material in occlusal surface, (C) Method for prosthesis removal, (D) Reuse of removed prosthesis, (E) Considerations in removing prosthesis.

Table 1. Means (SDs) of time used for screw-hole formation

	0F	0G	30F	30G	*P*
Time used (min)	5.18 (2.10)[a]	4.68 (1.76)[a]	10.91 (6.82)[b]	6.16 (3.46)[c]	<0.001

0F: 0-degree implant, freehand drilling; 0G: 0-degree implant, guided drilling; 30F: 30-degree tilted implant, freehand drilling; 30G: 30-degree tilted implant, guided drilling.
The same superscript letter indicates no statistical difference in the raw.

clinic, followed by the cement retention type and screw retention type. As to the material for occlusal surface, monolithic zirconia and non-precious alloys are commonly used. Participants had a similar preference to mechanical sectioning and screw-hole formation in retrieving prostheses. Most of the participants agreed that temporary reuse of the removed prosthesis is needed. As considerations during prosthesis removal, most participants responded that ease of removal is important, and the working time for removal and the re-usability of removed prosthesis should be taken into account.

The working time used for screw-hole formation is shown in Table 1. Generally, the working time was smaller in the guided drilling than in the freehand drilling. One-way analysis of variance presented that the time reduction in the guided drilling was significant in the 30-degree tilted implant condition ($P < 0.05$).

DISCUSSION

This study was designed to investigate the clinician's likelihood on the implant-supported fixed dental prosthetic treatment, and determine the time efficacy of the use of drilling guide in the formation of the screw hole in the prosthesis. In the questionnaire survey, most of the participants preferred the screw-cement retention type. When a screw hole does not exist, both the mechanical sectioning and hole formation can be used, and the participants responded easy removal of the prosthesis and the reuse of prosthesis might be important. Meanwhile, in the working time for preparing screw holes, the use of a drilling guide significantly decreased working time when the guides were applied to the tilted implants.

Anatomical limitations, such as pneumatization of the maxillary sinus, the proximity of the nerves, and lack of available bone, could cause implants to be placed in tilted position[13]. Sometimes, the angulated placement of implants is intentionally planned to avoid excessive bone grafting and to achieve esthetic goals[14]. In the tilted implants, it is difficult to estimate the position of the abutment screw because the screw is usually located out of the center of the crown. Based on our findings, the efficacy of the guide use was markedly greater as the implant was placed with a 30-degree angulation setting. These results correspond well with those presented in the earlier studies[11,12]. The previous studies examined the accuracy of hole formation in various implant inclination and bucco-lingual positions, and demonstrated that the guided drilling improves hole preparation. In particular, the use of guided drilling was meaningful in the implants highly angulated or malposed. Collectively, the present study proved the intimate relationship between the drilling guide and hole formation time, which could affect the convenience and satisfaction of clinicians and patients in clinic.

Implant therapy has become a daily routine procedure, and the number of implantations is further increasing. Thus, valid methods to retrieve implant prostheses become more essential. Although the survey in this study showed clear tendency and likelihood, bigger data might be required to analyze the results between different experiences and ethnic groups. The findings in the in vitro study should also be validated by comprehensive clinical studies. Thus, to confirm the results of the present study, further human factor-related studies are needed on the convenience and satisfaction in guided drilling for hole formation.

CONCLUSION

Within the limitations of this study, the following conclusions can be drawn. Clinicians showed high interest in the easy removal of implant prostheses and the reuse of prostheses in the accompanying survey. The effect of the drilling guide on the working time reduction of the screw-hole formation within the crown was evident when an implant was tilted by an angle of 30 degrees.

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