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Clinical and radiographic outcomes of immediate and delayed placement of dental implants in molar and premolar regions

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Abstract

Purpose: The purpose of this retrospective study was to determine clinical and radiographic outcomes of immediate and delayed placement of dental implants in molar and premolar regions.

Materials and methods: Clinical and radiographic records of 116 patients who received implants in molar and premolar regions were included in this study. After implantation, patients were recalled for assessments at 1 month, 3 months, 6 months, 1 year, and every year thereafter. In addition, anatomic location, type of prosthesis, gender, stage, diameter, and length of implants were analyzed.

Results: Of these 116 patients, 55 were males, and 61 were females. Their mean age was 50.9 years. They received 85 immediate implants and 147 delayed implants in molar and premolar regions. Gender, type of prosthesis, stage, implant diameter, and implant length were not significantly different between the immediate placement group and the delayed placement group, although anatomic locations were significantly different between the 2 groups. Their mean follow up time after dental implantation was 3 years (range, 6 months to 9 years). Kaplan-Meier survival estimates showed 97.8% probability of survival up to 9 years in the delayed placement group and 100% probability of survival up to 8 years in the immediate placement group. There was no significant difference in implant survival according to the time of implantation. No significant difference in cervical bone loss (CBL) at the mesial or distal side was found between the 2 groups. CBL according to anatomic location, the type of prosthesis, or gender was not significantly different either between the 2 groups. However, CBL at distal side of 1-stage approach was significantly ($P < .05$) smaller in the delayed placement group than that in the immediate placement group.

Conclusion: This study showed that immediate dental implantation in molar and premolar regions had good clinical and radiographic outcomes.

KEYWORDS
cervical bone loss, immediate implantation, molar and premolar region

1 | INTRODUCTION

The introduction of endosseous implant-supported prosthesis has significantly improved the restoring of masticatory function in partially or completely edentulous patients. Many studies have demonstrated that titanium dental implant is safe for oral rehabilitation with high success rates.[1–3]

Traditional guidelines for dental implant have suggested that a period of 3 to 6 months is needed for alveolar ridge remodeling following tooth extraction. Since the introduction of implant placement in fresh extraction socket in the late 1970s, this approach has been studied extensively.[4–8] Several recent papers have presented clear clinical guidelines for patient selection and/or optimal outcome of immediate implantation.[6,9–13]

Placement of an implant immediately after tooth extraction seems to reduce the number of surgical procedures and decrease comprehensive treatment time.[14] Conversely, misalignment of the extracted tooth may lead to unfavorable angulation of the fixture using this technique. In addition, stabilization may require more bone than what is available beyond the apex. Since vital structures such as the maxillary sinus and

the inferior alveolar nerve are closely related to the apex, immediate implantation may have hazardous consequences.[15,16] Moreover, mucogingival condition around the extraction socket may be unfavorable for primary closure.[15–20] Due to these reasons, immediate implantation in the molar region may be difficult. Few studies have compared the outcome of immediate dental implantation to that of delayed implantation in the molar region. Therefore, the objective of this study was to compare clinical and radiographic outcomes of immediate placement and delayed placement of dental implants in molar and premolar areas.

2 | MATERIALS AND METHODS

The Institutional Review Board of the Catholic University of Korea approved this study (Approval number: HC15RISI0098). A total of 116 patients who received implants in molar and premolar regions from January 2005 to December 2014 at the Department of Oral and Maxillofacial Surgery, Yeouido St. Mary's Hospital, the Catholic University of Korea, Republic of Korea, were included in this retrospective study. Their clinical and radiographic records were reviewed. Of these patients, 73 patients were in good health while 26 patients were under routine medications for cardiovascular problems. Ten patients were under controlled treatment for diabetes while 9 patients were receiving medications for osteoporosis. A total of 232 implants (Oneplant; Warantec, Seoul, Republic of Korea, or IS-II; Neobiotech, Seoul, Republic of Korea) were placed by 1 experienced implant surgeon.

2.1 | Presurgical preparation

Before implant installation, all patients received oral examinations, including the intra-arch relationship, bucco-lingual width, and inter-maxillary relationship. After that, panoramic radiographs and cone-beam computer tomography were taken to evaluate bone quantity, proximity from vital structures, and adjacent tooth angulation.

2.2 | Implant insertion surgery

To reduce the risk of infection, 625 mg of amoxicillin (Moxicle; Daewoong, Seoul, Republic of Korea) was administered at 1 hour before surgery. For patients who were allergic to penicillin, 150 mg of clindamycin (Fullgram; Samjin, Seoul, Republic of Korea) was administered instead. Surgical procedures were performed under local anesthesia.

2.3 | Immediate implantation

After a full-thickness flap was elevated, teeth were luxated with an elevator and extracted carefully using forceps to preserve the bone of the alveolus. Sockets were then debrided. Drillings were performed according to the manufacturer's written surgical protocol. Immediate implant placement was limited to defects with 3 or 4 walled sockets. Implants were placed in a manner that their upper surfaces were in line with the septal bone while the buccal and lingual surfaces of implant fixture contacted the bone. When there was no septal bone available for implant stabilization, the inner aspects of the socket walls and/or bone apical to the socket were engaged to stabilize the implant. If horizontal gap (more than 2 mm) occurred, ridge horizontal augmentation with xenogenous bone (Biocera, Oscotech, Seoul, Republic of Korea; bovine porous bone mineral coated dually with biocompatible calcium phosphate) was performed simultaneously with implant placement without using barrier membranes. The final tightening of the fixture into bone was performed using a torque wrench with primary stability of more than 35 Ncm. During 1-stage surgery, healing abutments was installed after inserting the implant. Flaps were adjusted to the implant and sutured with resorbable suture materials (Vicryl 4/0, Ethicon, France). During 2-stage surgery, the cover screw was placed on the implant and flaps were sutured in a way so that the implant was fully submerged with vertical releasing incisions.

2.4 | Delayed implantation

Implant procedure was carried out after a healing period of 3 months for the mandible and 6 months for the maxilla without socket preservation. After full-thickness flap elevation, surgical sites were prepared according to standard procedures. The coronal margin of the fixture was placed at the level of the bone crest with primary stability of more than 35 Ncm. During the 1-stage surgery, healing abutments was installed after inserting the implant and flaps were apically adjusted to the implant. During the 2-stage procedure, the cover screw was placed on the implant and flaps were sutured without tension.

2.5 | Postoperative management

After the surgical procedure, amoxicillin or clindamycin was continued for 5 days. In addition, chlorhexidine rinses were used for 2 weeks. The use of removable temporary prosthesis was not allowed.

2.6 | Restorative procedure

Impressions were taken at 1 month after implant fixtures were exposed in the 2-stage procedure. After 10 weeks of healing for the mandible and 22 weeks of healing for the maxilla following implant placement, traditional prosthetic procedures of screw- and cement- retained implant-supported dental prosthesis (SCRP) were performed to fabricate single or partial fixed restorations. They were inserted at 2 or 3 weeks after impressions were made. Abutments were torqued to respective implants with a torque gauge (25 Ncm) according to the manufacturer's instructions. Cementation of the restoration was performed with temporary luting cements. By loosening the abutment screw, the final restoration was taken out of the mouth and cleaned with chlorhexidine. The final restoration was then reinserted by abutment screw tightening. Access hole was filled with compacted cotton and resin. No prosthesis was connected to natural teeth.

2.7 | Measurement of cervical bone loss

Patients were recalled for radiographic and clinical examinations at 1 month, 3 months, 6 months, 1 year, and every year thereafter following implantation. During every visit, clinical assessment was performed for implants, prosthesis, and peri-implant tissues. Standardized periapical digital radiographs were taken using Max-GLS (Genoray, Sungnam,

Republic of Korea) to evaluate changes in crestal peri-implant bone level and peri-implant fixture radiolucency with film placed parallel to implants. X-ray beam was directed perpendicularly to implants. At least 2 implant threads should be visible on the radiograph. All radiographs were taken by 1 experienced radiologist. Measurement of cervical bone level was done at the mesial and distal sides of the fixture by 1 examiner. Cervical bone level was defined as the distance between the platform of the implant and the most coronal point of contact between the bone and the mesial and distal site of the implant. Cervical bone loss (CBL) was evaluated by calculating changes in cervical bone level over time. All images of periapical digital radiographs were analyzed using Triana software (Genoray, Sungnam, Republic of Korea).

2.8 | Implant success criteria

Implant success criteria were: no clinically detectable implant mobility, no radiographic evidence of peri-implant radiolucency, no sign or symptom of infection, and no bone loss in excess according to bone loss criterion reported previously.[2]

2.9 | Statistical analysis

Kaplan-Meier survival curves with a log-rank test at 95% confidence level were used to estimate survival rates of implants. Mixed model repeated measures analysis of variance was used to compare differences in CBL according to the time of implantation (immediate group vs delayed group). In addition, whether CBL was different according to implant placement region, gender, the type of prosthesis, or stage between the 2 groups (immediate placement vs delayed placement) was determined. Statistical analysis was performed using SAS Version 9.3 (SAS Institute, Cary, NC, United States).

3 | RESULTS

A total of 116 patients (55 males and 61 females, mean age of 50.9 years, age range, 17–76 years) received 85 immediate implants and 147 delayed implants in molar and premolar regions. Implant placement region, gender, prosthesis type, stage, implant diameter, and implant length in each group are summarized in Table 1. There was no significant difference in these variables between the 2 groups except for implant placement region ($P < .05$). Therefore, comparison results with regard to CBL between the immediate placement group and the delayed placement group in this study did not include the effect of gender, the type of prosthesis, stage, implant diameter, or implant length.

3.1 | Survival implant follow-up

The mean time of implant follow up was 3 years (SD, 2.2 years; median, 2 years), with a maximum of 9 years and a minimum of 6 months. Of 232 implants, 1 implant in the delayed group failed to maintain osseointegration. Kaplan-Meier survival estimates demonstrated a 97.8% probability of survival up to 9 years in the delayed group and 100% probability of survival up to 8 years in the immediate group.

TABLE 1 Overview of the examined surgical and patient-related parameters

	Immediate (%)	Delayed (%)	*P*-value[a]
Total number	85 (36.6)	147 (63.4)	
Premolar	33 (38.8)	28 (19.1)	.001[a]
Molar	52 (61.2)	119 (80.9)	
Single restoration	28 (32.9)	59 (40.1)	.28
Partial fixed prosthesis	57 (67.1)	88 (59.9)	
Male	31 (36.5)	68 (46.3)	.15
Female	54 (63.5)	79 (53.7)	
One Stage	35 (41.2)	60 (40.8)	.96
Two Stage	50 (58.8)	87 (59.2)	
Diameter	4.4 ± 0.3 mm	4.3 ± 0.3 mm	.24
Length	9.5 ± 0.9 mm	9.6 ± 0.8 mm	.52

[a]Log rank test ($P < .05$).

There was no significant ($P = .551$) difference in implant survival between the 2 groups (Figure 1).

3.2 | Analysis of CBL

Cervical bone level over time in each group is shown in Figure 2. Up to 1 year after the implant placement, cervical bone level was gradually decreased in both groups.

The mean CBL of these 232 implants was 0.23 mm at the mesial side, which was significantly ($P < .05$) smaller than that (0.29 mm) at the distal side during 2 years of follow up after implant placement. The mean CBL in the immediate placement group was 0.21 mm at the mesial side and 0.33 mm at the distal side at 2 years of follow up after implant placement. In the delayed placement group, the mean CBL was

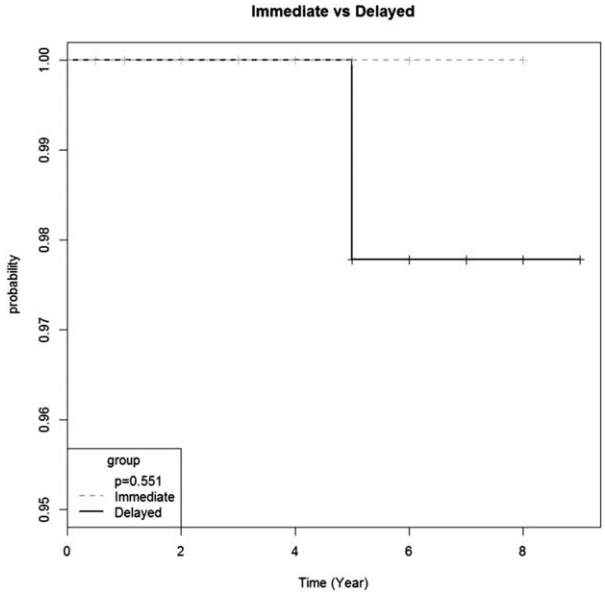

FIGURE 1 Implant survival

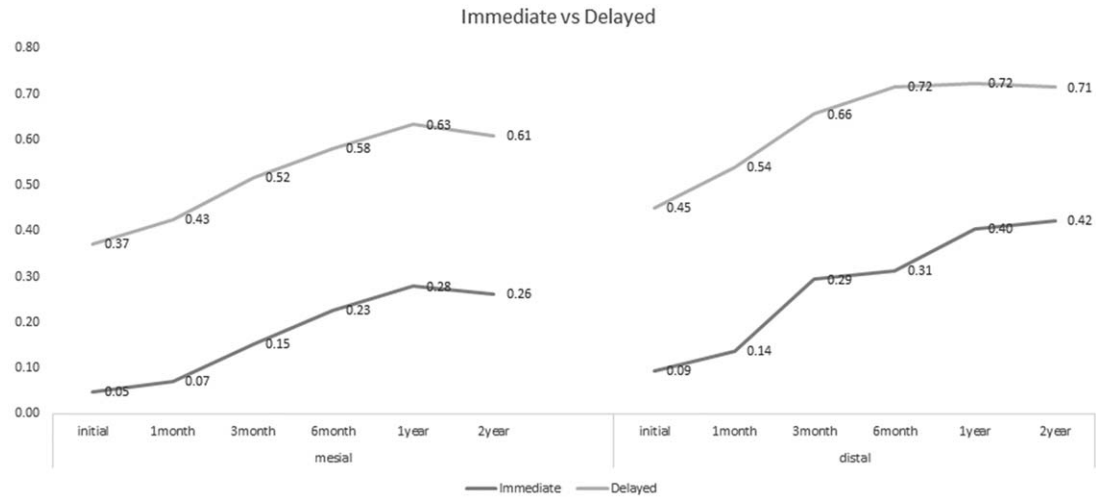

FIGURE 2 Cervical bone level over time in each group

0.24 mm mesially and 0.26 mm distally. There were significant differences in CBL between the mesial side and the distal side in either group. However, there was no significant difference in mesial CBL or distal CBL between the immediate placement group and the delayed placement group (mesial: $P = .81$, distal: $P = .54$) (Table 2). CBL values in each group at different time intervals are shown in Table 3. In the immediate placement group, CBL at the mesial side was statistically significant between "1 month" and "6 months" after implant placement. At the distal side, it was statistically significant between "1 month" and "3 months" or between "6 months" and "1 year" after implant placement. Conversely, in the delayed group, CBL was statistically significant between "implant placement" and "6 months" at the mesial side and the distal side.

CBL values were not significantly different between the immediate group and the delayed group according to anatomic location, the type of prosthesis, or gender (Table 4–6). However, using the 1-stage approach, CBL at the distal side was significantly ($P < .05$) different between the immediate placement group and the delayed placement group (Table 7).

TABLE 2 Cervical bone loss during 2 years

Cervical bone loss (mm)								
			Mean difference		SE		*P*	
	Comparison		M	D	M	D	M	D
Total	Initial	2 years	0.23	0.29	0.04	0.05	<.05	<.05
Immediate	Initial	2 years	0.21	0.33	0.07	0.09	<.05	<.05
Delayed	Initial	2 years	0.24	0.26	0.06	0.06	<.05	<.05
Difference	Immediate	Delayed	0.02	0.07	0.09	0.11	.81	.54

Abbreviations: M, mesial side; D, distal side; SE, standard error.
Mixed model repeated measures analysis of variance ($P < .05$).

TABLE 3 Cervical bone loss around implants

	No. of implants	Time interval	Initial ~ 1 month		1 month ~ 3 months		3 months ~ 6 months		6 months ~ 1 year		1 year ~ 2 years	
			M	D	M	D	M	D	M	D	M	D
Immediate	85	Mean difference	0.02	0.04	0.08	0.16	0.07	0.02	0.02	0.09	−0.02	0.02
		P	.27	.05	<.05	<.05	<.05	.54	.14	<.05	.64	.66
Delayed	147	Mean difference	0.05	0.09	0.09	0.12	0.06	0.06	0.05	0.01	−0.02	−0.01
		P	<.05	<.05	<.05	<.05	<.05	<.05	.06	.82	.33	.78

Abbreviations: M, mesial side; D, distal side; SE, standard error.
Mixed model repeated measures analysis of variance ($P < .05$).

TABLE 4 Cervical bone loss according to anatomic position

	Cervical bone loss (mm)								
				Mean difference		SE		*P*	
Anatomic position		Comparison		M	D	M	D	M	D
Premolar	Immediate	Initial	2 years	0.22	0.37	0.15	0.18	.14	< .05
	Delayed	Initial	2 years	0.33	0.37	0.16	0.2	< .05	.06
	Difference	Immediate	Delayed	−0.11	−0.01	0.22	0.27	.63	.98
Molar	Immediate	Initial	2 years	0.21	0.29	0.09	0.09	< .05	< .05
	Delayed	Initial	2 years	0.21	0.23	0.05	0.06	< .05	< .05
	Difference	Immediate	Delayed	0.01	0.06	0.1	0.11	.96	.55

Abbreviations: M, mesial side; D, distal side; SE, standard error.
Mixed model repeated measures analysis of variance ($P < .05$).

TABLE 5 Cervical bone loss according to prosthesis type

	Cervical bone loss (mm)								
				Mean difference		SE		*P*	
Prosthesis type		Comparison		M	D	M	D	M	D
Single	Immediate	Initial	2 years	0.17	0.2	0.15	0.18	.26	.28
	Delayed	Initial	2 years	0.18	0.19	0.1	0.12	.08	.12
	Difference	Immediate	Delayed	−0.01	0.01	0.18	0.21	.95	.98
Partial fixed prosthesis	Immediate	Initial	2 years	0.25	0.39	0.08	0.09	< .05	< .05
	Delayed	Initial	2 years	0.26	0.3	0.06	0.07	< .05	< .05
	Difference	Immediate	Delayed	−0.02	0.09	0.1	0.12	.86	.47

Abbreviations: M, mesial side; D, distal side; SE, standard error.
Mixed model repeated measures analysis of variance ($P < .05$).

TABLE 6 Cervical bone loss according to gender

	Cervical bone loss (mm)								
				Mean difference		SE		*P*	
Gender		Comparison		M	D	M	D	M	D
Male	Immediate	Initial	2 years	0.11	0.27	0.15	0.17	.49	.12
	Delayed	Initial	2 years	0.12	0.16	0.1	0.11	.23	.16
	Difference	Immediate	Delayed	−0.02	0.11	0.19	0.21	.93	.6
Female	Immediate	Initial	2 years	0.28	0.35	0.07	0.08	< .05	< .05
	Delayed	Initial	2 years	0.32	0.32	0.06	0.07	< .05	< .05
	Difference	Immediate	Delayed	−0.04	0.03	0.09	0.11	.65	.78

Abbreviations: M, mesial side; D, distal side; SE, standard error.
Mixed model repeated measures analysis of variance ($P < .05$).

TABLE 7 Cervical bone loss according to stage

	Cervical bone loss (mm)								
				Mean difference		SE		*P*	
Stage		Comparison		M	D	M	D	M	D
One-stage	Immediate	Initial	2 years	0.31	0.49	0.12	0.13	< .05	< .05
	Delayed	Initial	2 years	0.17	0.12	0.09	0.09	.06	.21
	Difference	Immediate	Delayed	0.14	0.37	0.15	0.16	.36	< .05
Two-stage	Immediate	Initial	2 years	0.15	0.22	0.09	0.11	.11	.06
	Delayed	Initial	2 years	0.28	0.35	0.07	0.08	< .05	< .05
	Difference	Immediate	Delayed	−0.13	−0.13	0.12	0.14	.26	.33

Abbreviations: M, mesial side; D, distal side; SE, standard error.
Mixed model repeated measures analysis of variance ($P < .05$).

4 | DISCUSSION

Placing an implant immediately after tooth extraction offers several advantages, including decreased rehabilitation treatment time, fewer surgical sessions, the ability to place the fixture in an ideal axial position, and positive psychological impact on the patient.[21] However, most available studies concerning immediate implantation have described their use in the anterior area for esthetic reason. Few studies have focused on immediate implantation in molar areas. The posterior edentulous region presents many unique and challenging conditions in implant dentistry. The main causes of alveolar bone height loss in the posterior region are periodontal disease and bone resorption after tooth loss. Poor bone quality in the posterior regions can compromise the initial implant stabilization and load transfer to the bone. For this reason, we compared clinical and radiographic outcomes of immediate placement and delayed placement of dental implants in the molar region in this study.

To avoid selection bias, implants were excluded when initial stability was less than 35 Ncm in this study. In addition, all implants were fabricated with SCRP type prosthesis. Immediate loading or early loading was excluded. Each patient was treated with the same protocol regardless of their medical status, occlusion, or surgical site condition.

In this study, no significant difference in gender, the type of prosthesis, stage, implant diameter, or implant length was found between the immediate placement group and the delayed placement group, although implant placement region was significantly different between the 2 groups. The immediate placement group showed higher premolar proportion than the delayed placement group.

Schwartz-Arad and colleagues have studied 56 immediate implants placed in the molar region (17 maxillary and 39 mandibular). In their study, second-stage surgery was carried out at 6.8 months in the maxilla and 5.5 months in the mandible after implantation. All implants were restored with fixed prostheses. The mean follow up period was 15 months (range, 4 to 60 months). Six implants were lost. They reported that the 5-year cumulative survival rate was 89.3%.[22] Prosper and colleagues have assessed 111 implants placed in fresh posterior sockets (75 maxillary and 36 mandibular). At second-stage surgery performed after 4 to 6 months, none of the implants showed any signs of mobility, peri-implantitis, or bone loss. After 4 years, their implant success rate was 97.3%.[23] Fugazzotto and colleagues have evaluated the predictability of implant placement at the time of maxillary molar extraction. A total of 83 tapered-end implants with an apical diameter of 4.1 mm and a neck diameter of 6.5 mm were placed in maxillary first or second molar sites. All implants were restored with single porcelain fused-to-precious metal crowns. They functioned successfully for up to 18 months (mean: 12.4 months).[24] Several studies have shown predictable results of immediate placement of implants after tooth extraction at maxillary or mandibular molar site.[22–28] Survival rates between 89% and 100% have been found for follow up period of 6 months to 5 years. In this study, Kaplan-Meier survival estimates demonstrated a 97.8% probability of survival up to 9 years in the delayed placement group and 100% probability of survival up to 8 years in the immediate placement group. Only 1 implant of the delayed group failed. This implant showed an abrupt CBL at 1 year after implantation. It was finally removed at 5 years after the implantation. The failure might be due to prosthetic or inflammatory factor around the implant rather than surgical factor.

Penarrocha-Diago and colleagues have assessed CBL around implants replacing molars. They reported that the overall mean implant CBL was 0.84 mm after 1 year of loading. In the case of immediate implants, CBL was 0.83 mm, which was not significant different from that (0.85 mm) positioned in mature bone.[29] Penarrocha-Oltra and colleagues have compared CBL at 1 year after placement of immediate and delayed implants in the maxillary molar region after studying a total of 123 implants (35 immediate and 88 delayed). The average CBL was reported to be 0.56 mm for immediate implants, which was not significantly different from that (0.67 mm) for delayed implants.[30] Conversely, Schwartz-Arad and colleagues have studied 381 implants (144 immediate and 237 delayed) in 44 edentulous patients to examine CBL with a mean follow up period of 3.5 years. They found that the posterior area in the maxilla and mandible showed higher CBL in the delayed implant group compared to that in the immediate implant group.[31] In this study, there was no significant difference in CBL between the immediate group and the delayed group at mesial or distal side during 2 years of follow up after the implantation.

Although immediate replacement of molars with implants seems to be a safe method, adverse conditions at the implant site (eg, insufficient amount of bone, poor bone quality, and in conflict with adjacent anatomical structures) may rule out the possibility of using this for specific cases. Therefore, careful case selection remains an important part of treatment planning.

5 | CONCLUSIONS

There was no significant difference in implant survival or CBL between immediate implantation and delayed implantation. Immediate implantation in molar and premolar regions can have successful clinical and radiographic outcomes.

CONFLICT OF INTEREST

Neither I nor any member of my immediate family has a financial relationship or interest (currently or within the past 12 months) with any entity producing, marketing, reselling, or distributing health care goods or services consumed by, or used on, patients.

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