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Knowledge, Awareness, Perception and Attitude Regarding Micro-Robotic Tools in Targeted Biofilm Detection and Treatment

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Abstract: Biofilm-associated infections represent a significant challenge in dentistry due to their resistance to conventional diagnostic and therapeutic approaches. Recent advances in nanotechnology and biomedical engineering have introduced micro-robotic tools capable of targeted biofilm detection and treatment.

Objective: To assess the knowledge, awareness, perception, and attitude regarding micro-robotic tools in targeted biofilm detection and treatment among undergraduate dental students.

Methods: A cross-sectional questionnaire-based study was conducted among 213 undergraduate dental students including III BDS, IV BDS students and interns. Data were collected using a structured questionnaire consisting of 15 multiple-choice questions. Descriptive statistics and chi-square tests were used for analysis.

Results: Most participants demonstrated limited knowledge and awareness regarding micro-robotic tools in targeted biofilm detection and treatment, reflecting the emerging nature of this technology in dentistry. However, the majority exhibited a positive attitude and strong interest in learning about micro-robotic applications as a future treatment modality. Students perceived micro-robotic tools as a potential advancement in precision dentistry, though concerns were expressed regarding cost, safety, technical complexity, and lack of clinical exposure.

Conclusion: Undergraduate dental students exhibited low knowledge but positive attitudes toward micro-robotic tools in targeted biofilm detection and treatment. Strengthening the inclusion of emerging technologies such as micro-robotics and nanotechnology within the dental curriculum, along with workshops, seminars, and hands-on training programs, can enhance preparedness for future clinical integration.

Keywords: Micro-robotic tools, Biofilm detection, Targeted therapy, Dental students.

INTRODUCTION

Biofilm-associated infections play a crucial role in the initiation and progression of various oral diseases, including dental caries, periodontal disease, peri-implantitis, and endodontic infections. Biofilms are structured communities of microorganisms embedded within a self-produced extracellular matrix, which makes them highly resistant to conventional antimicrobial therapies and diagnostic methods. Despite advances in preventive and therapeutic dentistry, effective detection and complete eradication of biofilms remain a significant clinical challenge.

Recent advancements in nanotechnology and biomedical engineering have led to the development of micro-robotic tools capable of operating at microscopic scales. These micro-robots are designed to navigate complex biological environments and can be programmed for targeted biofilm detection, disruption, and

localized drug delivery. Experimental studies have demonstrated their potential to enhance precision, improve treatment outcomes, and minimize damage to surrounding healthy tissues.

However, the successful translation of micro-robotic technology from laboratory research to routine dental practice depends not only on technological innovation but also on adequate awareness, understanding, and acceptance among future dental professionals. Assessing the knowledge, awareness, perception, and attitude (KAPA) of undergraduate dental students regarding micro-robotic tools in targeted biofilm detection and treatment is essential to identify educational gaps and to prepare them for the integration of advanced technologies into contemporary dental practice.

METHODOLOGY

Aim:

To assess the knowledge, awareness, perception, and attitude regarding micro-robotic tools in targeted biofilm detection and treatment among undergraduate dental students.

Objectives:

1. To evaluate the level of knowledge and awareness among dental students regarding micro-robotic tools in targeted biofilm detection and treatment.
2. To assess students' perception of the effectiveness, clinical applicability, and safety of micro-robotic technology.
3. To analyse the overall attitude of students toward the adoption of micro-robotic tools in dental practice.

Study Design and Area:

A cross-sectional study was conducted among undergraduate dental students of Mamata Dental College.

Study Population:

The study included 213 undergraduate dental students, comprising III BDS, IV BDS students, and interns.

Study Instrument: A pretested, structured questionnaire was used to collect data. The questionnaire consisted of demographic details followed by 15 multiple-choice questions assessing knowledge, awareness, perception, and attitude regarding micro-robotic tools in targeted biofilm detection and treatment.

Sampling Method: Convenience sampling was used.

Inclusion Criteria: Students present on the day of data collection and willing to participate. Exclusion Criteria: Students who were absent or unwilling to provide consent. Organising the Study: The study was designed using a self-administered questionnaire, focusing on demographic characteristics and knowledge and awareness regarding micro-robotic tools used in dental biofilm detection and treatment.

RESULTS

A total of 213 students participated in the study. Females constituted 59.6% (n = 127) of the sample, while males constituted 40.4% (n = 86). The age of participants ranged from 18 to 25 years, with a mean age of 21.89 ± 1.03 years.

Age Distribution:

N	Minimum	Maximum	Mean	Std deviation
213	18	25	21.89	1.035

Gender Distribution:

Gender	Frequency	Percent
Male	86	40.4
Female	127	59.6
Total	213	100

Year of Study Distribution:

Year	FREQUENCY	PERCENT
III BDS	73	34.3
IV BDS	84	39.4
INTERNS	56	26.3
TOTAL	213	100

Distribution and Comparison of Responses Based on Gender:

Item	Response	Male		Female		Chi square value	P value
		n	%	n	%		
Q1	1	11	12.7	20	15.7	11.646	0.05
	2	61	70.9	87	68.5		
	3	8	9.3	8	6.2		
	4	6	6.9	6	4.7		
Q2	1	8	32	17	68	2.750	0.432
	2	6	33.3	12	66.7		
	3	6	60	4	40		
	4	66	41.2	94	58.8		
Q3	1	57	40.7	83	59.3	1.920	0.589
	2	7	29.2	17	70.8		
	3	16	47.1	18	52.9		
	4	6	42.9	8	57.1		
Q4	1	6	33.3	12	66.7	0.697	0.874
	2	8	36.4	14	63.6		
	3	9	39.1	14	60.9		
	4	63	42	87	58		
Q5	1	79	91.8	97	76.3	2.464	0.03
	2	7	8.1	30	23.6		
Q6	1	71	42.6	98	57.4	3.720	0.05
	2	5	21.7	18	78.3		
	3	5	55.5	6	45.5		
	4	4	45.5	5	55.5		
Q7	1	74	40	111	60	1.489	0.475
	2	11	40.7	16	59.3		
	3	1	1.2	0	0		
	4	0	0	0	0		
Q8	1	8	33.3	16	66.7	3.980	0.049
	2	2	16.7	10	83.3		
	3	13	46.4	15	53.6		
	4	11	40.7	16	59.3		
Q9	1	40	41.2	99	58.8	0.671	0.413
	2	6	31.6	13	68.4		
	3	21	75	7	25		
	4	19	70.3	8	29.6		
Q10	1	5	25	15	75	7.241	0.065
	2	73	42.9	97	57.1		
	3	8	53.8	15	46.2		
Q11	1	8	53.3	7	46.7	2.655	0.448
	2	8	36.4	14	63.6		
	3	9	30	21	70		
	4	61	41.8	85	58.2		
Q12	1	2	18.2	9	81.8	6.418	0.093
	2	69	45.1	84	54.9		
	3	8	25.8	23	74.2		
	4	7	38.9	11	61.1		
Q13	1	62	42.8	83	57.2	2.311	0.510
	2	6	26.1	17	73.9		
	3	11	39.3	17	60.7		
	4	7	41.2	10	58.8		
	5	0	0	0	0		
Q14	1	73	84.8	110	86.6	0.221	0.974
	2	6	6.9	5	3.9		
	3	7	8.1	12	9.4		
Q15	1	3	23.1	10	76.9	1.793	0.06

	2	5	41.7	7	58.3		
	3	8	44.4	10	55.6		
	4	70	41.2	100	58.8		

$P \leq 0.05$ is statistically significant

Distribution and Comparison of Responses Based on Year of Study

Item	Response	III BDS (n)	%	IV BDS (n)	%	INTERN (n)	%	Chi-Value	P-Value
Q1	1	4	4.8	6	7.1	4	7.1	11.546	0.04*
	2	59	71	71	84.5	45	80.3		
	3	7	8.4	3	3.5	3	5.3		
	4	3	3.6	4	4.7	2	3.5		
Q2	1	6	24	10	40	9	36	28.554	0.0001*
	2	3	16.7	4	22.2	11	61.1		
	3	2	20	1	10	7	70		
	4	62	38.8	69	43.1	29	18.1		
Q3	1	55	39.3	58	41.4	27	19.3	21.445	0.002*
	2	4	16.7	6	25	14	58.3		
	3	12	35.3	12	35.3	10	29.4		
	4	1	7.1	8	57.1	5	35.7		
Q4	1	5	27.8	7	38.9	6	33.3	27.128	0.0001*
	2	2	9.1	6	27.3	14	63.6		
	3	7	30.4	6	26.1	10	43.5		
	4	59	39.3	65	43.3	26	17.3		
Q5	1	63	37.5	74	37.5	45	25	12.714	0.048*
	2	10	29.4	10	29.4	11	41.2		
Q6	1	60	34.7	69	40.5	47	24.7	2.257	0.323
	2	7	30.4	7	30.4	9	39.1		
	3	4	34.5	5	21.5				
	4	2	21.6	3	11.5				
Q7	1	64	34.6	74	40	47	25.4	2.712	0.607
	2	8	29.6	10	37	9	33.3		
	3	1	100	0	0	0	0		
	4	0	0	0	0	0	0		
Q8	1	9	37.5	10	41.7	5	20.8	34.979	0.001*
	2	1	8.3	2	16.7	9	75		
	3	7	25	6	21.4	15	53.6		
	4	14	51.9	8	29.6	5	18.5		
Q9	1	60	36.1	69	41.2	40	22.7	14.651	0.001*
	2	3	15.8	4	21.1	12	63.2		
	3	5	32.5	5	32.7	3	12.6		
	4	4	22.7	6	33.6	1	7.3		
Q10	1	7	35	7	35	6	30	12.306	0.055
	2	63	37.1	69	40.6	38	22.4		
	3	3	7.7	7	46.2	12	46.2		
Q11	1	6	40	5	33.3	4	26.7	33.408	0.0001*
	2	3	13.6	3	13.6	16	72.7		
	3	7	23.3	12	40	11	36.7		
	4	57	39	64	43.8	25	17.1		
Q12	1	1	9.1	4	36.4	6	54.5	14.996	0.020*
	2	59	38.6	63	41.2	31	20.3		
	3	8	25.8	13	41.9	10	32.3		

	4	5	27.8	4	22.2	9	50		
Q13	1	54	37.2	59	40.7	32	22.1	14.977	0.020*
	2	5	21.7	8	34.8	10	43.5		
	3	6	21.4	9	32.1	13	46.4		
	4	8	47.1	8	47.1	1	5.9		
	5	0	0	0	0	0	0		
Q14	1	62	18.8	74	43.8	45	37.5	17.924	0.006*
	2	3	23.1	1	7.7	9	69.2		
	3	8	42.1	9	47.4	2	10.5		
Q15	1	1	7.7	6	46.2	6	46.2	13.807	0.04*
	2	4	33.3	1	8.3	7	58.3		
	3	6	33.3	7	38.9	5	27.8		
	4	62	36.5	70	41.2	38	22.4		

$P \leq 0.05$ is statistically significant

DISCUSSION

The present study revealed that while the knowledge and awareness regarding micro-robotic tools in targeted biofilm detection and treatment were limited among undergraduate dental students, their perception and attitude were predominantly positive. This finding reflects the emerging nature of micro-robotic technology in dentistry and its limited inclusion in undergraduate curricula.

Micro-robotic tools represent a promising advancement in precision dentistry, offering targeted detection and disruption of biofilms that are resistant to conventional therapies. The observed interest among students highlights their readiness to embrace advanced technologies when adequate academic exposure is provided.

Similar studies assessing awareness of emerging technologies such as nanotechnology and robotics in dentistry have reported comparable outcomes, emphasizing the importance of early educational integration. Introducing concepts related to micro-robotics through seminars, workshops, and research-oriented learning can significantly enhance student preparedness and acceptance of innovative treatment modalities.

CONCLUSION:

Undergraduate dental students demonstrated low knowledge and awareness but positive attitudes and perceptions regarding micro-robotic tools in targeted biofilm detection and treatment. Integrating emerging technologies into the dental curriculum, along with practical exposure and academic training, will bridge existing knowledge gaps and promote the future adoption of micro-robotic applications in dental practice.

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