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ORIGINAL ARTICLE

Assessment of Spiritual Care Competency among Nurses in Sultan Ahmad Shah Medical Centre: A Cross-Sectional Study

Nor'ain A. Rashid[1*], Mohamad Ashraf Mohd Asri[2], Hamidah Othman[3], Nur Hidayati[4]

[1] Department of Critical Care Nursing, Kulliyyah of Nursing, International Islamic University Malaysia, 25200 Kuantan, Pahang.
[2] KPJ Ampang Puteri Specialist Hospital, 1, Jalan Memanda 9, Taman Dato Ahmad Razali, 68000 Ampang Jaya, Selangor.
[3] School of Nursing Sciences, Faculty of Medicine, Universiti Sultan Zainal Abidin (UniSZA), Campus Gong Badak, 21300 Kuala Terengganu.
[4] Medical Surgical Nursing Department, Faculty of Health Sciences, Universitas Muhammadiyah Lamongan, East Java Province, Indonesia.

* Corresponding author's email: norainabdulrashid@iium.edu.my

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Keywords: *Competency, Emotional care, Nurses, Professional Competence, Spiritual Care*

ABSTRACT

Spiritual care, which is considered a significant part of holistic nursing care, involves nurses to fulfil the patients' emotional, psychological, and spiritual needs. Spiritual care competency is an important aspect in maximising the quality of care to the patients and encouraging professionalism. This study aimed to assess the level of spiritual care competency among nurses in Sultan Ahmad Shah Medical Centre (SASMEC), and the association between sociodemographic factors with the level of spiritual care competency. This was a quantitative cross-sectional study conducted among 155 nurses from SASMEC IIUM using self-administered questionnaires, which included sociodemographic factors, the Spiritual Care Competency Scale (SCCS). Descriptive statistics, Chi Square Test, and Pearson Correlation Test were used in data analysis via SPSS version 27. The majority of the nurses in SASMEC IIUM perceived high levels of competency (99.4%). The highest mean difference among the domains were assessment and implementation of spiritual care (MD=12.368), and personal support and patient counselling (MD=12.368) while the lowest mean difference was communication (MD=4.155). Furthermore, there was no significant relationship between spiritual care competence and sociodemographic factors (age, marital status, educational level, nurses' experience, race, religion, and previous participation in training spiritual care programs), except for gender ($p<0.05$) in which

females acquired higher competency level than males. This study may help healthcare organizations and educational institutions to develop and implement strategies in enhancing and polishing the standard of spiritual care among nurses. Future studies are recommended to explain the natural association between sociodemographic factors and spiritual care competence.

INTRODUCTION

In healthcare settings, the competency of nurses in providing effective spiritual care is quite a concern. Despite recognising the importance of addressing the spiritual needs of patients and their relatives, there are several challenges and deficiencies in the delivery of spiritual care, leading to an inadequate level of competency in this area. Since nurses are bound to patients the most, the quality of care provided will also affect their health and well-being while still in admission, as proven by Irmak & Midilli (2021) that 93% of the nurses stated that spirituality and spiritual care influenced their patients' healing process. It can be said that patients' outcomes can be improved in terms of pain management, psychological well-being, and overall patient satisfaction. Spirituality is known to have beneficial effects on people's ability to evaluate their behaviours related to health and illness, adapt to changes, overcome obstacles, and find their strength and hope to recover (Karaman et al., 2022). The outcome may be minimal and unnoticeable to some patients, but it depends on how they receive and respond to the spiritual care delivered by nurses.

Another point is that developing competency among nurses on spiritual care practices aligns with a broader scope of healthcare system goals, primarily in enhancing patient and family-centred care to reduce healthcare disparities. There is a need to enlighten the importance of emphasising understanding and meeting patients' and families' spiritual needs, which contributes to a more holistic and comprehensive healthcare approach through educational interventions. As one of the possible results, the advantages of integrating art into spiritual care include patients and their families can find meaning in their illnesses and be able to express their feelings, both of which have been shown to impact their spiritual well-being (Zambezi et al., 2022). Hence, addressing spiritual needs to a further level for both patients and families may help to support emotional and psychological status even during difficult times.

However, the previous studies from Western and Malaysia lead to a research gap, which is a population gap since this study is limited and is under-researched. The study looks simple, but spiritual care will not be delivered in a correct and appropriate way if nurses do not reach the level of competency needed. By measuring their competency, future and alternatives can be proposed, such as developing a validation educational program or courses on spiritual care. Moreover, the findings of the study can help nurses to make a greater effort to engage in spiritual activities and keep exploring their spirituality based on their competency level. Thus, this study will describe the outcome and factors contributing to the problem in accordance with nurses' level of competence in spiritual care practices.

METHODOLOGY

This study used a quantitative cross-sectional design to investigate the level of spiritual care competency among nurses in SASMEC. The non-probability convenience sampling method was used. This study population were staff nurses in general wards in Sultan Ahmad Shah Medical Centre (SASMEC) that met the inclusion criteria.

Participants in the study were chosen on the basis of inclusion criteria. The inclusion criteria were ward nurses, mainly in

the General Surgery ward, Internal Medicine ward, Orthopedics ward, Obstetrics ward, and Gynecological ward in Sultan Haji Ahmad Shah Medical Centre (SASMEC) and nurses who understood the purpose of the study and voluntarily signed the consent. The exclusion criteria were nurses in all critical care departments and paediatrics as there might be differences in the spiritual care practices given to the different types of patients admitted compared to general wards. Other than that, working experience less than 1 year, and nurses who had no direct contact with patients were also excluded in this study.

The estimated sample size by using Raosoft Sample Size Calculator was 172 nurses. Of these, approximately 10% of the participants were expected to reject or drop out of the study due to personal circumstances or unforeseen challenges. Thus, the modified sample size after a 10% dropout rate was 190 students. However, this study only achieved 82% of the sample size, which was 155 participants.

The Spiritual Care Competence Scale (SCCS), adapted from a study of "Spiritual care competence among Malaysian staff nurses" by Ali H. Abusafia, Zakira Mamat, Nur Syahmina Rasudin, Mujahid Bakar, and Rohani Ismail (2021), consisted of 27 questions related to the nurses' competence in providing spiritual care to the patients. It consisted of six domains, which are assessment and implementation of spiritual care, professionalisation, and improvement of the quality of spiritual care, personal support and patient counselling, referral to professionals, attitude towards patient spirituality, and communication. All of these domains were compared using mean differences, while using mean average of 18, 18, 18, 9, 12, and 6, respectively as reference. It features a 6-point Likert scale with response options ranging from "strongly disagree" to "strongly agree". Total and subtotal scores were calculated, in which score lower than 64 was categorized as low spiritual competence, the score of 64-98 suggested average spiritual care, and the score of 99 and above demonstrated high spiritual competence. The reliability of Perceived Stress Scale (PSS) showed a good Cronbach's alpha of 0.926 with subdomains 0.685-0.851 and validity of acceptable fit indices for the 6-factor model: root mean square error of approximation (RMSEA) = 0.050, comparative fit index (CFI) = 0.900, Tucker–Lewis's index (TLI) = 0.885, and standardized root mean square residual (SRMR) = 0.065 (Abusafia et al., 2021). The SCCS instrument used in this study has demonstrated strong construct validity, as established by previous research (Abusafia et al., 2021).

Online questionnaires using the Google Form application were distributed to the nurses in SASMEC IIUM. The questionnaire consisted of two parts, which were sociodemographic factors, and Spiritual Care Competence Scale (SCCS). An informed consent was attached to the set of questionnaires in order to explain clearly the purpose of the study, procedure, confidentiality, and right to withdraw as well as the contact information of the researcher. The questionnaire will be filled out by the staff nurses who meet the inclusion criteria. However, the participants are free to choose not to participate in the study and they will be excluded from the study. To enhance response rates, two reminder emails were sent at two-week intervals, encouraging participation while maintaining a voluntary approach. Only voluntary participants will be selected by the researcher to answer the set of questionnaires. All the information given by the respondents were kept confidential throughout the research process. Data collection was done in two months from May 2024 until June 2024.

The Statistical Package for the Social Sciences (SPSS) Statistic version 27 was used to analyse the data. Descriptive statistics were used to describe the sociodemographic factors in terms of frequency (n) and percentage (%). Chi Square Test and Pearson Correlation Test were used to assess the association between

sociodemographic factors and the level of spiritual care competency among nurses in SASMEC IIUM. All hypotheses were tested and interpreted based on a significant p-value with a level of significance that was set at α = 0.05. An informed consent form was obtained from each participant. This study was approved by the Kulliyyah Nursing Postgraduate Research Committee (KNPGRC), International Islamic University Malaysia Research Ethic Committee (IREC) (ID No: IREC 2024-071), and SASMEC IIUM (Approval No.: IIR 24-29).

RESULT

Table 1 below shows the sociodemographic factors of the participants in the study. A total of 155 out of the initial 190 staff nurses (82%) participated and completed the questionnaire. 83.2% of the participants were female, and 54.8% were single. Significantly, 94.8% of the participants had diplomas, 100% were Muslims and Malays. More than half of the nurses had participated in previous spiritual care workshops, as well as attending continuous lessons. The mean (M) age of the nurses was 27.72, the standard deviation (SD) was 3.445, and the experience years were M=5.23 and SD=3.849.

Table 1: Sociodemographic factors

Factors	f	%	Mean (SD)
Gender			
Male	26	16.8	
Female	129	83.2	
Age			27.72 (3.445)
Marital status			
Single	85	54.8	
Married	66	42.6	
Divorced	4	2.6	
Educational level			
Diploma	147	94.8	
Bachelor	6	3.9	
Master	2	1.3	
PhD	0	0.0	
Religion			
Islam	155	100.0	
Buddha	0	0.0	
Hindu	0	0.0	
Kristian	0	0.0	
Race			
Malay	155	100.0	
Chinese	0	0.0	
India	0	0.0	
Experience years			5.23 (3.849)
Attendance previous workshop			
Yes	83	53.5	
No	72	46.5	
Attendance continuous lessons			
Yes	86	55.5	
No	69	44.5	

SD = Standard Deviation

Table 2 below shows the mean score of spiritual care competency score of 135.6 with a standard deviation of 15.56 and most of the nurses were in the high level (99.4%) of competence toward spiritual care. Meanwhile, Table 3 shows that the mean score of each domain of the questionnaire on the perception of spiritual care competence was significantly above the average mean. Comparing between domains, the highest mean difference among the domains were assessment and implementation of spiritual care, (MD=12.368), and personal support and patient counseling (MD=12.368) while the lowest mean difference was communication (MD=4.155).

Table 2: Level of Spiritual Care Competency

Level of Spiritual Care Competence (SCCS)	f (%)	Mean (SD
Low	-	
Average	1 (0.6)	
High	154 (99.4)	135.6 (15.56)

Table 3: Mean difference of domains in spiritual care competence

Domains	Mean (SD)	Average mean	Mean difference
Assessment and implementation of spiritual care	30.368 (3.675)	18	12.368
Professionalization and improving the quality of spiritual care	29.607 (4.271)	18	11.607

Personal support and patient counselling	30.368 (4.019)	18	12.368
Referral to professionals	14.529 (2.500)	9	5.529
Attitude towards patient spirituality	20.574 (3.415)	12	8.574
Communication	10.155 (1.759)	6	4.155

Chi Square Test and Pearson Correlation Test were used to determine the association between sociodemographic factors with the level of spiritual care competency among nurses in SASMEC IIUM. Table 4 below shows the association between sociodemographic factors and the level of competency. There was no significant relationship observed in the sociodemographic factors ($p>0.05$), except for gender where p-value is 0.025 ($p < 0.05$). The strength of correlation for age and experience years were very weak negative (-0.084) and very weak positive (0.010) relatively. It has been found that the majority of nurses were 100% Muslims and Malays.

DISCUSSION

This study examined the competency of nurses in providing spiritual care to patients. The result revealed that the mean score of spiritual care competence was 135.6, which indicates high levels of competency. This result is in contrast with another study conducted among nurses in public hospitals in Northeast of Peninsular Malaysia, which demonstrated a moderate mean score of spiritual care competence 95.44 (Abusafia et al., 2021). This suggests that spiritual care is being given more attention in nursing practice and continuous education.

The findings not only investigated the competency of nurses in providing spiritual care, but also demonstrated that the mean scores in each 6 domains were significantly above average. Assessment and implementation of spiritual care, and personal support and patient counseling have the highest mean differences (12.368) each. It is said that spiritual care is really provided

Table 4: Association between Sociodemographic Factors and Spiritual Care Competence

Factors	Spiritual care competence		X_2 (do)[a]	Correlation (R)[b]	*p*-value
	Average	High			
Gender			4.994 (1)		0.025[a]
Male	1 (0.2)	25 (25.8)			
Female	0 (0.8)	129 (128.2)			
Age				-0.084	0.299[b]
Marital status			0.829 (2)		0.661[a]
Single	1 (0.5)	84 (84.5)			
Married	0 (0.4)	66 (65.6)			
Divorced	0 (0.0)	4 (4.0)			
Educational level			0.055 (2)		0.973[a]
Diploma	1 (0.9)	146 (146.1)			
Bachelor	0 (0.0)	6 (6.0)			
Master	0 (0.0)	2 (2.0)			
PhD	0 (0.0)	0 (0.0)			
Religion			-		-
Islam					
Buddha	1 (1.0)	154 (154.0)			
Hindu					
Kristian					
Race			-		-
Malay					
Chinese	1 (1.0)	154 (154.0)			
India					
Experience years				0.010	0.903[b]

Attendance previous workshop Yes No	 0 (0.5) 1 (0.5)	 83 (82.5) 71 (71.5)	1.160 (1)		0.281[a]
Attendance continuous lessons Yes No	 0 (0.6) 1 (0.4)	 86 (85.4) 68 (68.6)	1.254 (1)		0.263[a]

Pearson chi-square test; [b] Pearson correlation test.

and evaluated alongside patients and their families, thus these domains are thought to be the core of spiritual care (Abusafia et al., 2021). On the other hand, there is a unit from the Islamic department in the hospital where the study was conducted, thus it could be one of the reasons that may have contributed to the greater results in the current study's spiritual care services.

The second highest domain was professionalization and improving the quality of spiritual care (MD=11.607) which is higher than the previous study conducted by Abusafia et al. (2021). This domain highlights the importance of continuous learning and adherence to professional standards in delivering effective spiritual care to patients. However, the mean difference score for the other three domains were a bit lower than these three domains. This indicates that there is a need for the nurses to accept and provide spiritual support to their patients, regardless of their race or religion (Abusafia et al., 2021). Besides, since nurses are part of a multidisciplinary team, they should be more considerate in identifying the spiritual needs of the patient by involving a professional care provider or chaplain in the treatment plan. Lastly, good communication reflects an effective care to the patient in fulfilling their needs on spirituality (Abusafia et al., 2021).

In this current study, it was found that there were no significant differences of sociodemographic characteristics towards spiritual care competency, except for gender (p=0.025). Female nurses have higher competency than males in providing proper spiritual care, which is in line with the result of previous studies conducted by Madu et al. (2023), Heidari et al. (2022) and Zeng et al. (2023). It is being said that females are commonly and more likely to be knowledgeable about spiritual care more than males (Madu et al., 2023). Moreover, female nurses might demonstrate higher competency levels, which may be attributed to several factors. Women generally exhibit greater empathy and emotional intelligence, which are essential components of providing spiritual care. Additionally, cultural and societal expectations may influence female nurses to be more attuned to patients' emotional and spiritual needs. Furthermore, female nurses may have had more opportunities or willingness to engage in conversations about spirituality with patients, contributing to their higher competency levels. By incorporating these explanations, we aim to provide a more nuanced interpretation of our results and enhance the discussion's depth.

In addition, the findings for the other characteristics were in contrast with studies conducted by Zhang et al. (2023), Semerci et al. (2021) and Machul et al. (2022) which suggest that age, race, religion, level of education, and years of experiences contribute to a significance association and play important roles towards spiritual care competency. Moreover, study by Seid & Abdo (2022) also revealed that spiritual care training was found to be related to spiritual care competency.

CONCLUSION

In conclusion, the majority of the nurses in SASMEC IIUM perceived high levels of competency. Meanwhile it is in contrast with multiple studies mentioned that most nurses had an average or moderate level of competency when it came to offering patients spiritual care (Abusafia et al., 2021;

Seid & Abdo, 2022; Milan Jr. & Buenaventura, 2021). Specifically, the domain of assessment and implementation of spiritual care, and personal support and patient counseling had higher mean differences than the others, while communication was the lowest one. Thus, there is a need in improving the communication to the patient on empowering the practice of spiritual care as Abusafia et al. (2021) stated that good communication reflects an effective care to the patient in fulfilling their needs on spirituality. Hopefully, the results from this study may help healthcare organizations and educational institutions to develop and implement strategies in enhancing and polishing the standard of spiritual care among nurses. Nursing administrators can maximize the quality of care by developing a validation educational program on spiritual care. Educational institutions should provide training and educational programs such as conducting regular workshops and seminars. It is also recommended that more future studies are done to explain the natural association between sociodemographic factors and spiritual care competence.

Relevance to Clinical Practice

The study highlights the need for improvement in communication, a critical aspect of providing effective spiritual care. Nurses must focus on better communication strategies to ensure patients' spiritual needs are fully met. Training in communication skills, particularly regarding spiritual care discussions, could be integrated into regular practice to enhance patient care quality.

Besides, nursing administrators and educational institutions should prioritize the development of validation educational programs on spiritual care, including workshops and seminars. These programs can strengthen areas where nurses show lower competency, such as communication, to ensure a more holistic approach to patient care.

The findings encourage healthcare organizations to use competency data to tailor strategies for different nurse demographics. For instance, understanding why female nurses exhibited higher spiritual care competency can inform gender-specific training or interventions to elevate all nurses' performance in spiritual care delivery.

Limitation Of Study

This study has been successfully conducted, however, there were a few limitations. Firstly, the extended duration of ethical approval from IIUM Research Ethics Committee (IREC) and SASMEC, which took approximately one month after submission. Due to the time constraint the researcher collected 82% of participants from the sample size, which was N = 155. Secondly, the researcher faced difficulty in recruiting participants in the research study. Therefore, the researcher had to personally reach each of the participants in order to collect the data. In addition, the researcher did not find any variety of data for race and religion in the study setting, plus it was conducted in only one hospital and not all departments involved, which may limit the capacity to generalize the findings pattern to other hospitals in Malaysia. Lastly, self-administered measures could have specific high response biases, lowering the accuracy of the collected data.

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ORIGINAL ARTICLE

Demographic and Clinical Characteristics of Neonates at Risk of Gentamicin-induced Nephrotoxicity: A Single-Center Study in Sabah Women and Children Hospital

Lisa Pei Ling Lee*, Hui Shan Lau

[1] Department of Pharmacy, Hospital Wanita Dan Kanak Kanak Sabah, 88996 Kota Kinabalu, Malaysia

* Corresponding author's email: lisalee@moh.gov.my

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ABSTRACT

Gentamicin is a clinically valuable aminoglycoside used empirically for the treatment of pneumonia, urinary tract infections, and neonatal sepsis. The recommended dosage for gentamicin in neonatal guidelines is 4 - 7 mg/kg at extended intervals of every 24, 36, or 48 hours, based on the subjects' gestational age. This study aimed to describe the demographic and clinical characteristics of neonates at risk of gentamicin-induced nephrotoxicity. This descriptive study was conducted among all neonatal patients receiving 5 mg/kg gentamicin with extended dosing intervals and had elevated blood gentamicin trough levels above 1 mg/L, indicating an increased risk of nephrotoxicity. Out of the total 44 subjects, 24 were preterm babies, and 27 had a body weight less than 2.5 kg. The subjects were categorized into two groups: the 24-hourly group and the 36-hourly group. There were 30 (68.2%) subjects in the 24-hourly group and 14 (31.8%) in the 36-hourly group. 20 out of 30 subjects in the 24-hourly group were term babies, whereas all subjects in the 36-hourly group were preterm babies. Of all 44 cases, gentamicin was administered during the first week of life in 31 cases, and after the first week of life in 13 cases. It appeared that the incidence of toxic gentamicin trough level was slightly lower in the 36-hourly group than in the 24-hourly group. It is recommended to use the 5 mg/kg 36-hourly regimen for all neonates in their first week of life when indicated.

Keywords: *Gentamicins, Serum, neonate, Demography, Nephrotoxicity*

INTRODUCTION

Aminoglycosides, being an older class of antimicrobials, have continued to be clinically valuable in fighting infections. They are potent, broad-spectrum antibiotics covering aerobic organisms, including gram-negative bacteria and mycobacteria through the inhibition of protein synthesis. In general, aminoglycosides are indicated for both empirical and directed treatment (Block & Blanchard, 2024). Gentamicin, a member of the aminoglycoside class, was introduced in 1963 and commonly used for the treatment of pneumonia and urinary tract infections in pediatric practice (Kato et al., 2022). In neonates, gentamicin is routinely used with ampicillin or penicillin (cloxacillin if suspecting staphylococcal infection) for empirical treatment of neonatal sepsis (Hussain et al., 2018).

Despite over 60 years of clinical experience, gentamicin population pharmacokinetic studies are still lacking specifically for subpopulations, including pediatric, elderly and critically ill patients. Optimization of dosing strategy in these subpopulations require more fine tuning. Additionally, individualization of the dosage remains a challenge due to the narrow therapeutic range and substantial interindividual variability of gentamicin pharmacokinetics (Hodiamont et al., 2022).

In terms of dosing regimen, there is considerable variation between references, hence, selection of an initial dosing regimen can be challenging. The common dosage regimen used is 4-7 mg/kg every 24, 36 or 48 hours, depending on the gestational age (BNF for Children, 2022; Micromedex, 2024). Due to the potential for ototoxicity and nephrotoxicity, serum monitoring of gentamicin is recommended to ensure levels are within therapeutic range. Nephrotoxicity of gentamicin closely correlates with trough concentrations greater than 2 mg/L. However, some literature suggested to aim for a trough concentration of less than 1 mg/L for extended-interval dosing since trough level of more than 1 mg/L suggests accumulation and potentially increases risk of nephrotoxicity (Darmstadt et al., 2008; Dersch-Mills et al., 2016).

In Sabah Women and Children Hospital, neonates with risk factors linked to neonatal sepsis such as maternal pyrexia, maternal Group B Streptococcus infection, septic blood counts, preterm or meconium aspiration syndrome are treated empirically with gentamicin alongside ampicillin or penicillin. The dosing of gentamicin commonly used in our setting is 5 mg/kg every 24 or 36 hours based on the gestational age (Table 1). Routine monitoring of serum trough level of gentamicin is done prior to the second or third dose due to the nephrotoxicity and ototoxicity risk. A therapeutic aim of serum gentamicin trough concentration of less than 1 mg/L was adopted as suggested in the Clinical Pharmacokinetics Pharmacy Handbook Malaysia (2019), a trough level above 1 mg/L is considered potentially toxic. Despite using recommended dosing, it was observed that over 30% of neonates treated with gentamicin experienced potential toxicity with gentamicin trough levels above 1 mg/L (Mustafa et al., 2022). Gonzalez et al. (2016) also found that 10% of neonates in their study experienced elevated initial trough gentamicin level. The objective of this study was to identify the demographic and clinical characteristics in neonates who are at risk of nephrotoxicity due to elevated gentamicin trough level despite application of recommended dosing regimen.

Table 1: Dosing of gentamicin in neonatal patients in Sabah Women and Children Hospital

Age Group		Dosing
Neonates	Gestational Age < 36 weeks, 1st week of life	5mg/kg 36 hourly
	Gestational Age < 36 weeks, after 1st week of life	5mg/kg 24 hourly
	Gestational Age ≥ 36 weeks	5mg/kg 24 hourly

METHODS

This was a single-center, cross sectional study conducted in the Sabah Women and Children Hospital. The Sabah Women and Children Hospital offers three levels of neonatal intensive care. Level 1 provides care for newborns with the least serious conditions, Level 2 is designed for those with moderately serious conditions, and Level 3 is reserved for neonates with the most serious conditions and requiring oxygen therapy. All patients who were prescribed intravenous gentamicin for more than one dose will be routinely checked for gentamicin trough level. The trough gentamicin serum level, which is associated with nephrotoxicity, will be measured within 30 minutes before the second or subsequent dose. Determination of gentamicin serum level was performed using the ABBOTT ALINITY I analyzer according to the instructions provided in the manufacturer's manual.

A non-probability sampling with purposive sampling method was employed. This study reviewed all neonates admitted to the Neonatal Intensive Care Unit (NICU) with at least one gentamicin serum level taken during admission from January till December 2019. Eligible patients were identified from the database of Therapeutic Drug Monitoring (TDM) records. TDM forms were screened for timing of blood samples taken and measured gentamicin levels. Only patients with blood samples taken within 30 minutes before second or subsequent gentamicin doses and had serum trough levels of above 1 mg/L were included.

The primary outcome of this study was to identify the demographic and clinical characteristics of neonatal patients who had elevated gentamicin trough level, hence, at risk of gentamicin-induced nephrotoxicity. Demographic data included gender, body weight, age, and ethnicity, whereas the clinical characteristics were described based on diagnosis, serum creatinine level, intubation status and presence of concurrent nephrotoxic drug.

The demographic and clinical characteristics for eligible patients were extracted from the medical records. Data extracted include gender, body weight, age, ethnicity, diagnosis, dosing of gentamicin, serum creatinine level, intubation status and presence of concurrent nephrotoxic drug. Extracted data were recorded on a pharmacotherapy review form published by the Ministry of Health Malaysia.
This research was registered with the National Medical Research Registry (NMRR-20-1531-54586), and it was approved by the Malaysian Institutional Review Board/ Independent Ethics Committee (MREC) (Ref: KKM/NIHSEC/P20-1926(4)). Permission to waive informed consent was obtained from the MREC due to the study's retrospective design.

Data were initially transcribed into a Microsoft Excel 2021 Spreadsheet and later categorised based on demographic and clinical characteristics. Weights were grouped based on extremely low (less than 1kg), very low (1 to less than 1.5kg), low (1.5 to less than 2.5kg) and normal birthweight (2.5kg and above) as described by the World Health Organization (WHO). Age groups for neonates were categorised in regard to extremely preterm (less than 28 weeks), very preterm (28 to less than 32 weeks), moderate to late preterm (32 to 37 weeks) and term births (more than 37 weeks) as per WHO definition. Categorical data were summarized as frequencies and percentages. Descriptive statistics were performed to depict the demographic and clinical characteristics data.

RESULTS

TIn total, 632 TDM requests were reviewed. 82 cases met the inclusion criteria. Out of these 82 cases with serum trough levels of above 1 mg/L, 10 cases had elevated serum trough level above 5 mg/L. These cases were excluded

as the level is unlikely with 5 mg/kg extended interval regimen and the result could be due to sampling error. Another 28 cases were not included due to inability to locate the complete medical records. Only 44 cases were included for final data analysis.

Table 2 showed the demographic characteristics of patients with toxic gentamicin trough level. There were 34 male subjects and 10 female subjects. 61.4% of patients were from extremely low, very low and low birth weight groups. Majority of the patients (54.5%) were preterm neonates less than 37 weeks of gestational age.

Table 2: Demographic Characteristics of Patients with Toxic Gentamicin Trough Level

Characteristics	Frequency (Percentage)
Gender	
Male	34 (77.3%)
Female	10 (22.7%)
Body weight (kg)	
-<1kg	2 (4.6%)
-1-<1.5kg	8 (18.2%)
-1.5-<2.5kg	17 (38.6%)
-2.5kg and above	17 (38.6%)
Age group	
-< 28 weeks	3 (6.8%)
-28 to 31 weeks	8 (18.2%)
-32 to 37 weeks	13 (29.5%)
-> 37 weeks	20 (45.5%)
Ethnicity	
Malay	2 (4.6%)
Chinese	4 (9.1%)
Bajau	14 (31.8%)
Kadazandusun	12 (27.2%)
Brunei	3 (6.8%)
Murut	1 (2.3%)
Others	8 (18.2%)

On the other hand, the clinical characteristics of patients with elevated gentamicin trough level were depicted in table 3. 29 out of 44 patients (65.9%) were diagnosed with neonatal sepsis followed by meconium aspiration syndrome (15.9%). 23 out of 44 subjects (52.3%) had normal serum creatinine of less than 60 umol/L. Majority of the patients were not intubated (61.4%) and not on concurrent nephrotoxic drugs (95.4%).

Dosing regimen wise, out of the total 44 subjects who had elevated blood

Table 3: Demographic Characteristics of Patients with Toxic Gentamicin Trough Level

Characteristics	Frequency (Percentage)
Diagnosis	
Group B Streptococcal (GBS) pneumonia	3 (6.8%)
Neonatal sepsis	29 (65.9%)
Meconium Aspiration Syndrome (MAS)	7 (15.9%)
Bronchopneumonia	2 (4.6%)
Others	3 (6.8%)
Serum creatinine (umol/L)	
less than 60	23 (52.3%)
60-89	18 (40.9%)
more than 90	3 (6.8%)
Intubated	
Yes	17 (38.6%)
No	27 (61.4%)
Concurrent nephrotoxic drug	
Yes	2 (4.6%)
No	42 (95.4%)

gentamicin trough levels, there were 30 (68.2%) subjects in the 24-hourly group and 14 (31.8%) in the 36-hourly group. All subjects in the 36-hourly group were preterm neonates initiated with gentamicin in their first week of life. Whereas in the 24-hourly group, majority of the subjects (16 out of 30) were term babies prescribed with gentamicin in their first week of life (Table 4).

DISCUSSION

Gentamicin is mainly cleared via glomerular filtration and excretory renal function is more affected in neonates than in adults due to physiological and developmental factors (Pacifici, 2015). This study showed that the majority of the patients with toxic gentamicin trough level were premature neonates (<37 weeks) and with body weight of less than 2.5kg. These findings were consistent with a review by Llanos et al. (2017) that age and body weight were two main factors that influence gentamicin clearance. These two covariates were reported to have a positive relationship on clearance. Moreover, these findings were physiologically plausible, as neonatal nephrogenesis is not completed until 34 to 36 weeks of gestation (Gonzalez et al., 2016). Therefore, lower clearance in preterm neonates compared to term neonates resulted

Table 4: Distribution of Toxic Gentamicin Level Based on Age Group & Time of Gentamicin Initiation

Dosing	5mg/kg 36 hourly		5mg/kg 24 hourly	
Time of gentamicin initiation	**Served in the first week of life**	**Served after first week of life**	**Served in the first week of life**	**Served after first week of life**
Age	**Frequency (Percentage)**	**Frequency (Percentage)**	**Frequency (Percentage)**	**Frequency (Percentage)**
<28 weeks	2 (4.6%)	0	0	1 (2.3%)
28-31 weeks	5 (11.3%)	0	0	3 (6.8%)
32-37 weeks	7 (15.9%)	0	1 (2.3%)	5 (11.3%)
>37 weeks	0	0	16 (36.4%)	4 (9.1%)

in a higher possibility of elevated gentamicin trough level.

As gentamicin is primarily excreted via the renal pathway, renal function is the key component in gentamicin therapy (Ali et al., 2012). Clinically, serum creatinine values are the most convenient method to evaluate the renal function. However, in neonates and younger children, creatinine clearance and serum creatinine were often not identified as the influencing factors on gentamicin clearance, as they may not accurately reflect renal function in these populations. It is possible that a neonate may have significant renal injury with only slight serum creatinine increment since the muscle mass is small. For instance, a rise in serum creatinine from 1 mg/dl (88 umol/L) to 2 mg/dl (176 umol/L) as evident in renal injury in an adult may only result in an increment from 0.3 mg/dl (26.5 umol/L) to 0.6 mg/dl (53 umol/L) in a young infant (Llanos-Paez et al., 2017). In this study, majority of the patients (52.3%) with toxic gentamicin trough level had normal serum creatinine level of <60 umol/L. However, normal creatinine level in neonates might not necessarily reflect normal renal function (Llanos-Paez et al., 2017). Measurement of urinary volume may be another appropriate index for assessing renal function (Kato et al., 2022). But it was not evaluated in this study because not all neonatal patients receiving gentamicin had their urinary volume measured. In our hospital setting, all neonates from NICU Level 3 require strict input and output (I/O) charting, but this is not applicable to neonates admitted to Level 2 and Level 1. Strict I/O charting typically required in neonates who are diagnosed with serious clinical condition like Persistent Pulmonary Hypertension of the Newborn (PPHN), Congenital Heart Disease (CHD), and Necrotizing Enterocolitis (NEC) or those undergoing surgical procedures (Constanza, 2022). Besides urinary volume, measurement of cystatin C which is directly related to glomerular filtration rate and not influenced by body mass, may be a valuable biomarker to assess the renal function in neonates (Baum, 2016). However, cystatin C is significantly more costly than serum creatinine thereby widespread measurements of cystatin C may not be feasible, specifically in resource-limited settings (Hundemer et al., 2024). In summary, the serum creatinine level should not be the sole indicator when deciding on the dosing of gentamicin, as it may not accurately reflect true renal function.

The ototoxicity of gentamicin was not investigated in this study, as gentamicin appears to have low ototoxicity rates in neonates when used with extended dosing intervals for a short duration (Ekmen & Doğan, 2021). This could be attributed to the less mature vestibular hair cells in neonates, and the maturation process may take a few weeks, resulting in reduced uptake of gentamicin into the cells and, consequently, less ototoxic effect. (Zaubitzer et al., 2024).

The use of TDM to optimize target

achievement and reduce toxicity is crucial, as the pharmacokinetic parameters of gentamicin can vary considerably in neonates. Clearance ranges from 0.49 to 6.3 L/h/70kg, and volume of distribution ranges from 26.6 to 63.7 L/70kg (Hollander et al., 2023). The trough serum level of gentamicin should be monitored in all patients receiving at least three doses, as the risk of nephrotoxicity increases with prolonged duration. On the other hand, peak levels are useful for evaluating the efficacy of gentamicin, as it is a concentration-dependent antibiotic. However, peak serum level monitoring was not routinely performed in our setting. In fact, peak levels are typically not required, as with extended interval dosing, the larger doses used are expected to yield concentrations sufficient for clinical efficacy (Mustafa et al., 2022). It has been reported that across the entire neonatal age and weight range, the gentamicin dosing regimens in the Dutch National Formulary for Children, the British National Formulary (BNF) for Children, Neofax, and the Red Book resulted in adequate peak but elevated trough concentrations (Pacifici, 2015). Model-based simulations also suggest that most neonates born at a gestational age above 34 weeks are expected to reach a peak level of at least 8 mg/L with a standard dose of 4 mg/kg once daily (Fuchs et al., 2014). Therefore, trough-only monitoring may be sufficient for neonatal patients prescribed gentamicin for empirical treatment.

Dosing of gentamicin is primarily initiated based on available guidelines, followed by serum level monitoring and subsequent dose adjustments. In view of the varied dosing recommendations across different neonatal guidelines and based on clinical practice, our hospital adopted the dosing regimen depicted in Table 1. Our study reported that 30 out of 44 subjects with toxic gentamicin trough levels received the drug at 24-hour intervals. In particular, 16 of these 30 patients were term babies receiving gentamicin during their first week of life. The dosing regimen in our setting for term neonates requiring gentamicin in their first week of life is 5 mg/kg every 24 hours, similar to the recommendations in Micromedex (Micromedex Products: Gentamicin, 2024). Conversely, BNF for Children (2022) suggests administering gentamicin at a longer interval of every 36 hours in all neonates up to 7 days of life. Mustafa et al. (2022), who studied gentamicin serum levels in one-week-old neonates, also suggested that a prolonged dosing interval of 36 hours should be implemented in neonates weighing less than 2 kg, regardless of gestational age.

Theoretically, nephrogenesis is considered complete in term neonates; hence, administration of gentamicin at 24-hour intervals in term babies is acceptable. However, significant functional changes continue to take place during the first week of life as the neonate matures. Renal function only starts to stabilize by the 5th to 7th postnatal day and slowly progresses to eventually reach the adult state (Sulemanji & Vakili, 2013). Furthermore, a study by Hollander et al. (2023) found that 65.1% of term neonates on 5 mg/kg 24-hourly gentamicin had elevated trough levels of >1 mg/L, indicating an overestimation of clearance in term neonates. On the other hand, a prospective cohort study by Van Maarseveen et al. (2016) found that a gentamicin dosing regimen of 5 mg/kg every 36 hours led to the attainment of safe trough concentrations in all neonates >32 weeks gestation. Thus, these findings may warrant revising the gentamicin dosing interval to every 36 hours in term neonates during their first week of life due to maturational changes.

Our study has some noteworthy limitations. First, it was conducted at a single-center, which may limit the external validity of our findings, as they may not generalize well to other neonatal populations with different demographics and healthcare systems. The smaller sample size and the homogeneous environment of a single center could also introduce bias. Second, there is a lack of a

control group. This study only reviewed patients with elevated trough gentamicin levels; hence, there is no comparison group to evaluate possible risk factors that could be useful in predicting or preventing nephrotoxicity. Third, due to the retrospective design of our study, challenges such as missing or incomplete documentation encountered during data extraction from medical records may have resulted in inadequate data collection and potential biases. Missing data might mean that certain patient demographics or clinical characteristics are underrepresented, potentially impacting the generalizability and accuracy of the findings.

CONCLUSION

Gentamicin is a valuable aminoglycoside for treating infections in the neonatal population. Considering the significant variability in gentamicin pharmacokinetics within this population, serum level monitoring plays an essential role in ensuring adequate efficacy while minimizing toxicity. Gestational age and weight appear to be important demographic factors for predicting nephrotoxicity. Renal function in neonates should be assessed using multiple methods rather than relying solely on serum creatinine levels. In terms of dosing, the incidence of elevated gentamicin trough levels, which correlates with nephrotoxicity, was slightly lower in the 36-hourly group compared to the 24-hourly group. This study may serve as a basis for modifying prescribing patterns by recommending a 36-hourly regimen for all neonates during their first week of life and for neonates weighing less than 2 kg, regardless of gestational age. However, more in-depth studies are needed to confirm these findings. Future research could focus on validating these findings through multi-center studies to ensure broader applicability and reliability.

CONFLICT OF INTEREST

No conflict of interest was declared by the authors

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ORIGINAL ARTICLE

Knowledge, Attitude and Practice Among Overweight Patients in General Medical Clinic, Hospital Queen Elizabeth

Kalaiarasan Gemini*, Ng Eng Kian

[1] Department of Internal Medicine, Hospital Queen Elizabeth, 88586 Kota Kinabalu, Sabah, Malaysia

*Corresponding author's email: kalai9210@gmail.com

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ABSTRACT

Obesity is a complex and an epidemic disease distributed among all age groups. Knowledge, attitude and practice (KAP) studies are largely used to understand the disease burden in a certain population. Thus, the aim of this study is to evaluate KAP of overweight patients in an urban tertiary centre setting and test the validity of the questionnaire used to assess the KAP. This hospital-based cross-sectional study involves 113 overweight patients based on Asia Pacific Body Mass Index (BMI) scale aged 12 to 50 years old attending the general medical clinic in Hospital Queen Elizabeth, Sabah. Patients were chosen based on convenience sampling with a calculates sample size of 93. Sociodemographic details and BMI awareness were gathered after obtaining patient's consent. For the assessment of attitude and preparedness level of patient to lose weight, a modified Likert scale questionnaire was used. Sociodemographic data and the stage of readiness were analysed based on the mean distribution and standard deviation. Chi-square tests, Fisher exact tests and One-Way ANOVA tests were used to see the correlation between basic sociodemographic data namely age, gender, race, education level, and BMI with awareness. Subsequently, Chi-square test and One-Way ANOVA tests was used to assess the correlation of BMI classification, BMI awareness level and their preparedness to enrol to weight loss program based on stage of readiness. In addition, to find out the influence of BMI awareness level and BMI classification

Keywords: *Knowledge, Body mass index (BMI), Overweight, Readiness*

on response to each question from the Likert scale questionnaire, analysis using Chi-square test was done. Finally, the reliability and validity of the questionnaire was tested from two statistical validity point of view with the first using predictive validity via multiple regression (Criterion Validity) and second calculating the Cronbach's alpha coefficient (reliability) as well as the convergent and discriminant validity (Construct Validity). Predominant involvement of female participants and obesity class 2 stage were observed overall. Only 53% of the obese class respondents were aware of their BMI with all the pre-obese class patients being unaware of their BMI signifying the poor awareness. Statistically, only BMI and gender has a significant correlation with awareness. ($p<0.001$, $p=0.048$) Majority of the patients were grouped under the stage of preparation and above but no significant association analysed towards BMI awareness level. (n:109, 96%) Notably, significant correlations were found between question 4 and BMI awareness level ($F=4.485$, $p=0.036$) as well as question 3 and BMI class ($F=3.364$, $p=0.0038$). The questionnaire used was deemed valid and reliable by confirming the internal consistency using Cronbach's alpha ($\alpha=0.69$) and assessing the convergent and discriminative validity ($0.3<r<0.7$). All the questionnaire variables were statistically significant, marking the predictive validity of the questionnaire. $F(5, 107) = 59.928$, $p < 0.001$, $R2 = 0.737$. This study identifies most of the patient in an urban setting belongs to obese class with poor awareness on their BMI scale despite majority of them being prepared to lose weight. Applying the validity of the questionnaire, this small-scale study concludes the need of awareness teaching to aid in obesity prevention.

INTRODUCTION

Obesity is a chronic and a complex disease with influence of varied factors ranging from genetics to nutrition to physical activity. Unfortunately, this debilitating disease has been on the rise at an alarming rate globally with 2.5 billion adults (18 years and older) being overweight with 890 million out of the former living in obesity (Global Burden of Disease Study, 2024). Focusing nationally, a review on Obesity in the Asia-Pacific Region in 2024 reveals that Malaysia was the leading ASEAN nation with greatest obesity extent (Lui et al., 2024). Focusing on the issue of overweight, which is a precursor to obesity, it has also been on the rise with Malaysia showing a prevalence of 50.1% in 2023 (Chong et al., 2023).

The definition of overweight and obesity is based on the body mass index (BMI). The measurement of a BMI is an indirect calculation of the nutritional status of a person which more often than not correlates with the accumulated total body fat (Mandal, 2023). Asia-Pacific BMI classification was initially introduced in 2000 by World Health Organization Western pacific Region after considering the health risk associated with obesity occurring at a lower BMI in Asian population (World Health Organization, 2000). It was then modified according to the individual Asian countries based on local data (WHO Expert Consultation, 2004). Even though the Asia-Pacific BMI's implication on the health and economy were vastly studied, the awareness on this is poorly investigated. It is crucial to understand the weightage that overweight and obesity carries as a local study done in University Putra Malaysia highlights the disease burden of overweight being 2728 person years and 2951 person years for obesity (Foo et al., 2018).

Focusing on Sabah a Borneo state, a study on obesity prevalence was done by National Health and Morbidity Survey (NHMS) back in 2023 with Sabah having the lowest rates of obesity (9.7%) (Institute for Public Health, 2024). However, study on awareness of obesity was not done extensively. Focusing on that, a recent study done in a rural area from Kudat, Sabah did assess awareness level as a part of their study in which there was a significant correlation between body

weight perception and actual body weight ($p< 0.0005$) (Yi et al., 2022). Self-awareness of body weight is a crucial assistant to maintain or lose weight, research in these areas is least explored (Park et al., 2019). KAP studies are a useful method to assess nutrient-related knowledge and targeting activities specifically designed to tackle nutrition related diseases. (Food and Agriculture Organization of UN, 2014). In view of limited available data on KAP studies in Sabah, this study was conducted evaluating the KAP of overweight patients attending tertiary clinic in an urban setting with the aim of initiating obesity clinic with multidisciplinary involvement. Likert scale questionnaire is a very useful and reliable tool used in assessing KAP (Koo et al., 2005). Thus, Likert scale questionnaire was used to assess the stage of readiness for weight loss programme. In order for a valid and reliable assessment, internal consistency, criterion validity and construct validity were assessed.

MATERIALS AND METHODS

Study Area, Study Population and Setting

This was a hospital based cross-sectional study carried out in Hospital Queen Elizabeth, a tertiary hospital in Kota Kinabalu. Data collection was started from mid-May till mid-August 2024. The study participants were males and females aged 50 years and below attending the clinic. Consent was taken from each participant prior to the start of the study. The inclusion criteria for this study were patients age 50 years old and below with lower age limit of 12 years old attending general medical clinic with body mass index (BMI) of 23 and above in accordance to classification of overweight from Asia pacific BMI scale reference. Stated are the reference based on the BMI scale used which are underweight (< 18.5kg/m2), normal (18.5 – 22.9kg/m2), overweight (23.0 – 24.9kg/m2) and obese (> 25kg/m2). Exclusion criteria are those patients who are bed bound or mobility restricted patients and patients with serious comorbid of ischemic heart disease or/and stroke and patients who are mentally incapacitated. Participants were recruited using convenience sampling, with random selection applied among patients attending the General Medical Clinic who met the predefined inclusion criteria.

Questionnaire Design and Data Collection

A questionnaire was developed and used to interview patients on the awareness of obesity and readiness to lose weight. Originally, the questionnaire was primarily used in obesity clinic to test their readiness to lose weight. Awareness level was added to the questionnaire and assessed based on a Yes/No question on perceiving the difference of participants actual BMI compared to Asia Pacific Body Mass Index (BMI). The questionnaire exploring the stage of readiness for weight loss program was further modified based on the journal on 'The Transtheoretical Model of Health Behaviour Change' by Prochaska JO and Velicer WF. Permission was obtained for their usage in this study. A total of 5 questions were listed with each questions score varying from 1 (less likely) to 5 (most likely) was attributed. Question 1 'How ready are you to lose weight', Question 2 'How certain are you that you will stick with the program for the time it will take to lose the weight you want to', Question 3 'With all the stressors in your life, how possible will it be for you to stick to a healthier way of eating', Question 4 'How confident are you in your ability to decrease the amount of food you eat', Question 5 'Are you ready to add more physical activity to your routine (e.g more walking or more stair climbing)'. Cumulative score was then calculated and graded into stages of change. A total score of 5 and below was staged as precontemplation, score of 6-10 staged as contemplation, score of 11-15 staged as preparation, score of 16-20 staged as action level 1, and finally score 21-25 staged as maintenance. Patients in stages of action level 1 and maintenance were concluded to be ready for weight loss initiation program. Since the questionnaire was modified for the use of this study, the validity of the questionnaire was

investigated. The questionnaire also contains questions relevant to demography data and body mass index (BMI). Demographic data that were included namely age, gender, race, and education level. Another set of questionnaires translated in local Malay language was prepared and given to participants for better understanding.

For measurement of body mass index, manual weighing scale and a stadiometer were used. Zero error was checked. The participants were asked to remove shoes, outer jacket and objects from their pockets for precise weighing. The weighing was done thrice and the average was taken as the final reading. The height measurement was done twice with participants heads positioned parallel to the baseboard and the average was taken as the final reading.

Sample Size Calculation and Statistical Analysis

The sample size was calculated using methodology for determining survey sample size with a Likert scale primary outcome published by Park and Jung (Park & Jung, 2009). A calculated sample size of at least 93 participants were needed to detect a medium-sized correlation coefficient between a 5-point scale used for each Likert item (k=5) with 80% power and a significance level of 0.05. A correlation coefficient of 0.3 was taken for moderate effect size with a relative tolerable error of 10% and correlation of variation of population (C=0.3). The sample size was calculated using G*Power software.

A total of 113 questionnaires were collected. All data collection were done manually and subsequently keyed in a MS Excel spreadsheet and subsequently analysed using SPSS 27 (IBM Corp.). Descriptive analysis of mean and standard deviation was used for sociodemographic data. The primary statistic test used were Chi- square, Fisher Exact test and One-way ANOVA test to analyse the correlations. The values of $P < 0.05$ were considered significant.

Questionnaire Validity

A Likert-scale questionnaire validity requires 4 different types of validity namely face validity, content validity, construct validity and criterion validity. In our study, we intend to measure two of the statistically relevant validity of the questionnaire by calculating criterion validity (predictive value) and construct validity (Cronbach's alpha, convergent and discriminative validity). A multilinear regression was used to find out predictive validity of questionnaire used to assess readiness level. The model included all the 5 Likert-scale questions from the questionnaire as the independent variables in relevance to the stage of readiness for weight loss. The assumptions for multilinear regression were tested. Scatterplots were done to confirm the linear relationship between the dependent and independent variables. Normality was assessed using Q-Q plot which showed the data were normally distributed. Homoscedasticity was assessed through residual plots where the values were randomly scattered around zero. Finally, variance inflation factors (VIFs) were ranging at 1.1-1.6 and tolerance were ranging at 0.6-0.8 confirming no multicollinearity observed. The values of $P < 0.05$ were considered significant. Cronbach's alpha coefficient was calculated and interpreted to be acceptable internal consistency if the value was > 0.5. Convergent and discriminative validity was tested using Pearson Correlation Coefficients(r). Values of $0.3<r<0.7$ were accepted to be valid since the measures were continuous and normally distributed.

This study was approved by Medical Research and Ethics Committee, Ministry of Health, Malaysia (NMRR ID-: 24-01453-ZXU) IIR.

RESULTS

Sociodemographic Characteristics

A total of 113 participants were included, with a mean age of 37 years (SD = 9.06). Slightly more than half were female (52%),

and the majority were in early adulthood (31-50 years, 79%). Based on the Asia-Pacific BMI classification, nearly half (49%) were in obese class 2 (≥ 30 kg/m2). Most participants had at least secondary education (96%) and the most represented ethnic group was Bajau (21%) as the study site was conducted in Kota Kinabalu city (Table 1).

Table 1: Sociodemographic study.

Parameters	N (%)
Age (groupings) **Mean (SD) - 37 (9.06)**	
12-18 (teenagers)	4 (3)
19-30 (young adulthood)	20 (18)
31-50 (early adulthood)	89 (79)
Gender	
Male	54 (48)
Female	59 (52)
BMI classification **Mean (SD) – 30.6 (6.04)**	
Pre-obese	18 (16)
Obese Class 1	40 (35)
Obese Class 2	55 (49)
Education Level	
Primary	5 (4)
Secondary	30 (27)
Diploma	42 (37)
Degree & above	36 (32)
Race	
Malay	8 (7)
Chinese	21 (19)
Indian	1 (1)
Kadazan	23 (20)
Dusun	20 (18)
Bajau	24 (21)
Brunei	5 (4)
Bisaya	1 (1)
Murut	3 (3)
Suluk	2 (2)
Sino-kadazan	1 (1)
Sungai	2 (2)
Bugis	2 (2)

Awareness of BMI

The first part of the study is divided into sections exploring the awareness and attitude towards losing weight. Thus, the initial component to be investigated would be awareness. It would be measured based on patient's knowledge (yes/no) on noticing the difference between their actual BMI compared to the Asia- Pacific body mass index (BMI) scale. Table 2 shows the correlation between awareness and sociodemographic parameters. Patients in early adulthood with male participants were noticed to be slightly more aware of their BMI classification than female participants. Additionally, the highest number of patients in the obese class 2 were aware of their BMI. However, all of the pre-obese class patients were not aware of their BMI index. The only significant correlations with awareness level were noticed with BMI classification and gender with p value of <0.001 and 0.048 respectively (OR 2.194; 95% CI 1.00-4.81).

Readiness to Lose Weight

The second section of the research then focuses on the stage of readiness of the patients to lose weight. Based on the questionnaire involving 5 different scale-based questions assessing patient's willingness and commitment for weight loss, a stage of change was formulated from the cumulative score. Action Level 1 and maintenance stage were classified as ready for weight loss program. Based on that, at least 96% of patients were ready for weight loss program. Majority of the patients in obese class (59%) were grouped under action level 1. Finally, even though most of the patient who were aware on their BMI level and under obese class BMI, there were no significant association noticed on the readiness level (Table 3).

Questionnaire Analysis

Each question from the questionnaire were focused to get a better outlook on their scoring on the readiness. The first question questions patients on their readiness on weight loss. The second question discusses on the certainty of patients to continue the weight loss program for time required. Third question tests patient's confidence in staying with the weight loss program with the stressors in their life. Fourth question tests on possibility of patients to reduce food intake. Final questions

discuss on willingness of patients to add physical activity on top of weight reduction. Question 3 showed a significant association with BMI classification, with the obese class 2 participants demonstrating greater confidence (F=3.364, p=0.0038) (Table 4). Question 4 was significantly associated with BMI awareness, with participants who were aware reporting greater readiness (F=4.485, p=0.036).

Questionnaire Validity and Reliability

The reliability of the stage of readiness for weight loss program Likert scale questionnaire was tested via the internal consistency using Cronbach's alpha. The Cronbach's alpha for the five-item scale was 0.69, suggesting good internal consistency within the items of the scale (N=113). No items were deleted during the analysis, and the scale is considered reliable

Table 2: BMI awareness.

Parameters	Yes N (%)	No N (%)	*P*-value	OR	95% CI
Age (groupings)					
12-18 (teenagers)	1 (1)	3 (3)	0.251[a]	0.288	0.006-11.7
19-30 (young adulthood)	14 (12)	6 (5)			
31-50 (early adulthood)	56 (50)	33 (29)			
Gender					
Male	39 (35)	15 (13)	0.048[a]	2.194	1.00-4.81
Female	32 (28)	27 (24)			
BMI classification					
Pre-obese	0 (0)	18 (16)	< 0.001[a]		
Obese Class 1	23 (11)	17 (15)			
Obese Class 2	48 (42)	7 (6)			
Education Level					
Primary	3 (2)	2 (2)	1.000[a]	0.868	0.125-6.138
Secondary	19 (17)	11 (10)			
Diploma	26 (23)	16 (14)			
Degree & above	23 (20)	13 (12)			
Race					
Malay	7 (6)	1 (1)	0.247[a]		
Chinese	10 (9)	11 (10)			
Indian	1 (1)	0 (0)			
Kadazan	17 (15)	6 (5)			
Dusun	12 (11)	8 (7)			
Bajau	17 (15)	7 (6)			
Brunei	2 (2)	3 (3)			
Bisaya	0 (0)	1 (1)			
Murut	1 (1)	2 (2)			
Suluk	2 (2)	0 (0)			
Sino-kadazan	0 (0)	1 (1)			
Sungai	1 (1)	1 (1)			
Bugis	1 (1)	1 (1)			

[a] Chi-square test/Fisher Exact Test- value p acceptance of null hypothesis p<0.05, OR: Odds Ration, CI: Confidence Interval

Table 3: Readiness to lose weight.

Parameters	Preparation	Action Level 1	Maintenance	P-value	OR	95% CI
BMI classification						
Preobese	2 (2)	13 (12)	3 (3)	0.182[a]	2.407	0.591-7.411
Obese Class 1	2 (2)	27 (24)	11 (10)			
Obese Class 2	0 (0)	40 (35)	15 (13)			
Awareness Yes No	 1 (1) 3 (3)	 49 (43) 31 (27)	 21 (19) 8 (7)	0.157[a]	0.61	0.25-1.48

[a] Chi-square test/Fisher Exact Test- value p acceptance of null hypothesis p<0.05, OR: Odds Ration, CI: Confidence Interval

Table 4: Questionnaire analysis

QUESTION 1 – How Ready Are You to Lose Weight?

Parameters	N(μ)	df1,df2	F	*P*-value
Awareness Yes No	 71 (4.15) 42 (4.02)	1, 111	1.469	0.228a
BMI classification				
Preobese	18 (3.94)	2, 110	1.067	0.348a
Obese Class 1	40 (4.18)			
Obese Class 2	55 (4.11)			

[a] Chi-square test/Fisher Exact Test - value p acceptance of null hypothesis p<0.05

QUESTION 2 – How Certain Are You That You Will Stick with The Program for The Time It Will Take to Lose the Weight You Want To?

Parameters	N(μ)	df1,df2	F	*P*-value
Awareness Yes No	 71 (3.85) 42 (3.74)	1, 111	0.896	0.346a
BMI classification				
Preobese	18 (3.83)	2, 110	1.647	0.197a
Obese Class 1	40 (3.68)			
Obese Class 2	55 (3.89)			

[a] Chi-square test/Fisher Exact Test - value p acceptance of null hypothesis p<0.05

QUESTION 3 – With All the Stressors in Your Life, How Possible Will It Be for You to Stick to a Healthier Way of Eating?

Parameters	N(μ)	df1,df2	F	*P*-value
Awareness Yes No	 71 (3.63) 42 (3.55)	1, 111	0.357	0.551a
BMI classification				
Preobese	18 (3.39)	2, 110	3.364	0.038a
Obese Class 1	40 (3.45)			
Obese Class 2	55 (3.78)			

[a] Chi-square test/Fisher Exact Test - value p acceptance of null hypothesis p<0.05

QUESTION 4 – How Confident Are You in Your Ability to Decrease the Amount of Food You Eat?

Parameters	N(μ)	df1,df2	F	*P*-value
Awareness Yes No	 71 (3.89) 42 (3.62)	1, 111	4.485	0.036[a]
BMI classification				
Preobese	18 (3.72)	2, 110	0.152	0.859[a]
Obese Class 1	40 (3.78)			
Obese Class 2	55 (3.82)			

[a] Chi-square test/Fisher Exact Test - value p acceptance of null hypothesis p<0.05

QUESTION 5 – Are You Ready to Add More Physical Activity to Your Routine?

Parameters	N(μ)	df1,df2	F	*P*-value
Awareness Yes No	 71 (3.93) 42 (3.88)	1, 111	0.161	0.689a
BMI classification				
Preobese	18 (3.89)	0.161	0.036	0.965a
Obese Class 1	40 (3.90)	0.689a		
Obese Class 2	55 (3.93)			

[a] Chi-square test/Fisher Exact Test - value p acceptance of null hypothesis p<0.05

for its intended use. The significant value of the Cronbach's alpha was based on a study conducted by Taber (2017), after comparing 69 references which categorizes each value to the reliability scale.

The validity of the questionnaire was assessed through calculating criterion validity (predictive value) and construct validity (Convergent and Discriminative validity). We inferred that this questionnaire had moderate validity as each item in the questionnaire had values between 0.3 and 0.7 using Pearson Correlation Coefficient (0.3<r<0.7). The threshold was taken as such based on a research paper conducted by Yusoff et al (2021) reviewing multiple references to formulate the needed value to be deemed acceptable. It was concluded that a value of 0.3 and below are not acceptable and the higher the value rises the better the correlation is.

A multiple regression was done to assess the predictive validity from the five scale questions listed with all the assumptions validated. These variables show statistically significantly predicted readiness level from all five questions, $F(5, 107) = 59.928$, $p < 0.001$, $R2 = 0.737$. Among them, question 3 contributing the most to predicting readiness ($t = 6.973$, $p < 0.001$) (Table 5).

DISCUSSION

Obesity is a global disease as the number of people affected by it is enormous with Asian countries leading the battle against it. In recent research done by WHO in 2024, both overweight and obesity shown a marked increase in the past four decades (World Health Organization, 2024). In Malaysia per se the last nationwide survey on obesity prevalence was done back in 2023 with a sample size of 9782 adults aged 18 and above. The results from the study shows that female, aged 30-59 years old, Malay race, married, adequate health literacy was significantly associated with overweight (Chong et al, 2023). In Sabah, the last obesity prevalence study was done in a rural community by Tan and team back in May 2022 showing a prevalence rate of 71.5% which is surprising. However, this study was focused in a rural community of Northern Borneo (Yi et al., 2022). Keeping that in mind, this study was

Table 5: Multiple regression on readiness

R	R square	F	df1	df2	Sig.
0.858	0.737	59.928	5	107	< 0.001

Coefficients

	Standardized Coefficient Beta	t	Sig.
(Constant)		-6.089	< 0.001
Question 1	0.177	3.222	0.002
Question 2	0.198	3.742	< 0.001
Question 3	0.389	6.973	< 0.001
Question 4	0.286	4.515	< 0.001
Question 5	0.201	3.225	0.002

instead conducted to assess the knowledge on awareness of Asian Pacific body mass index (BMI) scale among the urban population in the state of Sabah. We also test their attitude by assessing their readiness to lose weight.

A total of 113 overweight patients participated in this research. Overall, the study shows female predominance of obesity rate which coincides with the world obesity statistics in 2022 and the local Malaysian statistics done in 2019 (World Obesity Federation, 2024; Institute for Public Health, 2019). Age group distribution form world statistics also matches with this study with patients in early adulthood (31-50 years) being affected the most but the distribution of age in world statistic is seen above 18 years old in general (World Obesity Federation, 2024). Comparing this to the local Sabah study, the age distribution was also noted to be between 35 and 50 years old (Yi et al., 2022). A conclusion can be made with distribution of age being fairly similar in urban and rural setting. Most of the patients in this study were grouped in obese class 2. This is an alarming situation, as Sabah in general was known to be one of the least obese populated states in Malaysia (NHMS, 2023). Besides, the general consensus based on National Health Screening Initiative 2023 54.4% Malaysians are overweight (32.6%) or obese (21.8%) (Institute for Public Health, 2024). The discrepancy on obesity preponderance could be due to the small sample size and the focus on overweight patients and not the general public. Sabah being a multiethnic state, it has close to 42 different ethnic group dispersed along the state. However ethnic distribution in each district was not widely studied. In our study, Bajau and Kadazan ethnic forms the main bulk of ethnicity. In addition to that, since the study was conducted in Kota Kinabalu city, the literacy rate is relatively high compared to the other districts with majority of the patients having at least secondary level education. This is in comparable with the study done by Tan and team in a rural area where tertiary level education is about 25% compared to more than 50% in our study (Yi et al., 2022).

The introduction to Asia Pacific BMI index scale was done on February 2000 by World Health Organization Western Pacific Region (World Health Organization, 2000). Since the introduction, awareness study has not been widely conducted. In our study, we used the Asia Pacific BMI index as it is well studied and streamlined to understand patients' awareness. The result shows a significant inference between BMI and awareness. Point to note is that all the pre-obese patients are unaware of their BMI scale but at least half of obese patients are aware. This hovers towards lack in early exposure on overweight as this being the precursor for obesity. More awareness study is required to imply the importance of acknowledging pre-obesity class. One study that explains the impacts of pre-obesity, titled body mass index and all-cause mortality. In this study after analysing

a total of 10625411 participants, it was found that patients with BMI 20.0-25.0 kg/m2 had a minimal all-cause mortality while those who are out of this target BMI have a statistically increased risk (HR: 1.00, CI 0.98-1.02) (Global BMI Mortality Collaboration, 2016). The risk of all-cause mortality increases exponentially with the increase in the BMI as evidenced by their hazard's ratio, thus highlighting the importance of early identification and intervention. Interestingly male patients were more aware of their BMI compared to their female counterparts (72% vs 54%) despite having lower literacy rate. A number of studies done previously, reveals that females were more aware and perceptive of their BMI compared to males (Zapka et al, 2009, Jeinie et al, 2021). The awareness difference found compared to our study could possibly be due to more male obese class participants (80%) compared to females (90%), thus they perceived better. Besides, since males tend to accrue more visceral fat, leading to android body shape which is more visible compared to females (Palmer et al, 2015). this could also have influenced the outcome of our study. However, no studies were found implying the significance of this correlation thus concluding this as an incidental finding.

Moving on to stage of readiness level to lose weight, the general outlook was positive with most patients were in at least the stage of action level. The stage of readiness to lose weight varied across different regions across the world. An example, a study conducted in Boston, USA where 61% of the participants were at advanced stage of readiness to lose weight (Wee et al., 2005). However, there was a different finding on a survey conducted in Iran where majority of the patients were in the precontemplation stage of weight loss readiness (Ghannadiasl et al., 2014). The difference in the finding could be due to many factors mainly the study design. The striking difference was noted in the study location since the research group from USA did their study in a primary care clinic while the Iran researchers conducted theirs in a nutrition clinic. Looking back at our study, since it was done in an urban tertiary hospital clinic, participants were patients who came to seek help. Thus, this could be the primary factor for the former mentioned result. Moving on, even though multiple factors were studied on their influence on stage of readiness, the distinct parameter to focus would be awareness. Since most of the patients in the study were aware of their BMI but it reflects moderately on their readiness level as a large portion of the patients were in action level. In addition, there was no significant correlation seen between awareness and BMI. This is in contrast to a study done in a clinic setting which shows patients perceiving weight as a health risk were more likely to be at advanced stages of readiness to lose weight (AOR 5.6; CI 2.5-12.5) (Wee et al, 2005). Again the difference in the study design and location could have influenced the result.

Questionnaire designed for this study was tailored to the basic understanding of the patient on the preparedness level. Question 4 focuses on the confidence level on decreasing food intake amount and it was the only item that had a significant correlation with awareness. The inclusion of food portion in assessing nutrition awareness is limited. However, one of study conducted by Wee et al (2005) included food portion reduction. Since it was an observational study, the conclusion derived was that obese patients in action stage were more inclined to reduce food portion compared to normal BMI patients. This can be inferred as patient who are aware of their weight are willing to reduce their food intake thus implying the same in our study. Nevertheless, the possibility of the other questions having no significant correlation with BMI awareness could be due to the subjective mannerism of the questions compared to an objective measure in question 4 in terms of food quantification. Following that, it was also noted that participants in Obese class 2 were more confident in sticking to a healthier diet despite stressors. Even though

the reporting was positive, the applicability in real world still remains a question. Based on a study conducted on obese participants on the limiting factors for adherence to weight loss intervention, absence of prescribed diet and boredom of dieting were two main factors identified (Trujillo-Garrido et al, 2022). This was observed in patients who had enrolled themselves in the weight loss program. Since our study focuses on patient's readiness to enrol in weight loss program, these limiting factors should be taken into account during the endorsement of a weight loss programme locally.

The Likert scale questionnaire validity was assessed primarily based on the construct validity and criterion validity as stated in the methods and results. Based on the book Weighing the Options: Criteria for Evaluating Weight-Management Program, a Likert scale stage of readiness for weight loss questionnaire can be validated using both construct and criterion validity (Institute of Medicine Committee to Develop Criteria for Evaluating the Outcomes of Approaches to Prevent and Treat Obesity, 1995). However, the inability to assess the correlation between this study and a gold standard study may not reflect the actual reflection of the validity weightage. Besides, the study was done in a small scale which again might not fully reflect the weightage of the validity. Nevertheless, all the five questions were still statistically significant in terms of predictive correlation with the third question which assesses patient's confidence in staying in the weight loss programme stand out most. This proved the predictive validity of the questionnaire which predicts the accuracy of future weight loss outcomes or engagement in a weight loss program.

This is the first study to be conducted in an urban tertiary centre in Sabah exploring the BMI awareness and weight loss readiness among overweight and obese patients in a clinic setting using a validated and reliable questionnaire. This study would be a stepping stone for an obesity clinic set up in Hospital Queen Elizabeth. As vast evidence gathered on the transtheoretical model in effective weight loss across Borneo, more detailed research on them has to be conducted in Sabah (Cheah et al, 2019, Chang, 2007). The study has several limitations. The relatively small sample size, selected through convenience sampling, restricts the generalizability on the findings to the wider population. Besides, the sociodemographic differences between urban and district of Sabah limit the applicability of the results to the broader Sabah population. In addition to that, involvement of a single centre being general medical clinic of Hospital Queen Elizabeth may not fully reflect the diversity of patients in Kota Kinabalu. Furthermore, data on readiness to lose weight were self-reported, which may be subject to social desirability or recall bias. Despite these limitations, the findings offer valuable insights and a foundation for future research and intervention development. Further studies with larger sample sizes and multicentre designs are recommended to validate these findings and better inform targeted public health strategies across Sabah and Malaysia.

CONCLUSION

This study is the first to explore BMI awareness and weight loss among overweight patients in an urban tertiary setting in Sabah. Most patients being in obese class had poor awareness of their BMI. Nevertheless, most of them were prepared to lose the weight as evidence by the state of readiness. These findings underscore the urgent need for structured obesity intervention programs with a focus on early education and personalized support. Thus, an obesity clinic focusing on weight loss programme is justified to be set up across Sabah.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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REVIEW ARTICLE

Lithium as Neglected Drinking Water Parameter and Effect on Foetal Growth: A Review

Muhammad Ridzwan Rafi'i*, Mohd Hasni Jaafar, Azmawati Mohamed Nawi, Rosnah Sutan, Shahrul Azhar Md Hanif

[1] Department Of Public Health Medicine, Medical Faculty, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Cheras, 56000, Kuala Lumpur, Malaysia.

*Corresponding author's email: ridzwanrafii@yahoo.com

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ABSTRACT

Lithium (Li) is a metal that is currently very important due to its use in several industrial activities. Recently, Li has been recognised as an emerging environmental pollutant, attracting numerous researchers globally due to its high environmental concentration, particularly in surface water. Several neonatal health impacts due to Li exposure from drinking water were extensively studied and reviewed previously, such as prematurity, miscarriages, and hypothyroidism. This review aims to assess the impact of Li exposure through drinking water on foetal growth parameters, specifically examining the relationship between maternal Li concentrations and foetal measurements. We searched articles published between January 1, 1990, and September 10, 2024, using five electronic databases. A total of 36 articles were eliminated during the screening process. Ultimately, just one article (n = 1) was approved in this review. In the particular study, they found a negative correlation between maternal blood Li levels (median 25; range 1.9–145 µg/L) and urine Li levels (median 1645; range 105–4600 µg/L) and all foetal measurements (body, head, and femur) during the second trimester, as well as birth length. A rise of 100 µg/L in blood Li was generally linked to a 2 cm reduction in birth length and foetal growth. Existing evidence indicates a negative association between Li exposure from drinking water and foetal development. Additionally, the long-term health implications for offspring exposed to Li in utero, primarily

through contaminated drinking water, are under-researched, underscoring the need for more comprehensive studies that examine both immediate and chronic health outcomes.

INTRODUCTION

Lithium (Li) is a metal that is currently very important due to its use in several industrial activities such as lithium-ion battery production, ceramic, glass, and grease production. (Kavanagh et al., 2018). Recently, Li has been regarded as an emerging environmental pollutant and has attracted many researchers globally due to its high environmental concentration, especially in surface water (Bolan et al., 2021; M. R. Rafi'i et al., 2024; Robinson et al., 2018). Furthermore, it was found in several studies that several non-mining countries for Li around the world (Italy, Hungary, Korea, Austria) also surprisingly found a significant Li concentration in their water bodies, which were between 60.8µg/L and 689.4µg/L (Choi et al., 2019; Dobosy et al., 2023; Giotakos et al., 2013; Pompili et al., 2015).

Although Li is a natural component of soil, rock, and groundwater, human activities have increased its concentrations much higher in watersheds. Furthermore, anthropogenic activities have also deposited Li chemically dissolved in rivers and physically transported Li into the ocean and river bed sediments (Bolan et al., 2021; M. R. Rafi'i et al., 2024). Additionally, it is essential that Li also tends to accumulate in aquatic systems due to its high mobility and solubility. In addition, urban runoff can also spread this Li material contamination to the heads of other surrounding drain systems and main water bodies (Mrozik et al., 2021). However, Li continues to be a largely overlooked criterion in drinking water quality assessment and control in most countries, despite the availability of more evidence on its potential impact on human health through surface water sources (Liew et al., 2023; M. R. Rafi'i et al., 2024; Mahmudiono et al., 2023).
Besides that, Li has had a very long history with therapeutic benefits for psychiatry in general, and most of all for mood disorders. Management or control of the manic phase of bipolar disorder is assisted by its property of acting as a manic depression mood stabiliser. (Rybakowski, 2020). Several studies have shown that when Li is used therapeutically to treat depression, it can affect foetal development. In addition to that, it is a cause for great concern since it shows that mild exposure to Li during pregnancy can interfere with essential development processes, which can create adverse effects, including low birth weight with associated neurological impairments.(Diav-Citrin et al., 2014; Jacobson et al., 1992).

In addition, with the shift in global focus on the health of mothers and children to protect vulnerable groups (pregnant women and their developing foetuses), it is now time again to reassess the recently discovered impurities in potable water, such as Li, and their health impacts on them. Several neonatal health outcomes of Li exposure via potable water were debated and examined in great detail previously, such as prematurity, spontaneous abortions, and hypothyroidism (Fornaro et al., 2020; Poels et al., 2018). However, there are few studies on Li exposure from drinking water consumption and its impact on foetal development. Furthermore, the relative importance of Li exposure from prescribed medicines versus consumption of drinking water is never debated, and we now have very few review articles of the evidence in print. Therefore, this review aims to assess the impact of Li exposure through drinking water on foetal growth parameters, specifically examining the relationship between maternal Li concentrations and foetal measurements such as body size, head circumference, and femur length, as well as birth outcomes like birth length by synthesising the published research on Li exposure through drinking water and its possible implications for foetal growth.

MATERIALS AND METHODS

Article search strategy and databases

We searched articles published between January 1, 1990, and September 10, 2024, using five electronic databases (PubMed, Scopus, Web of Science, Cochrane Library and Ovid). The search terms included: (lithium) AND (water OR surface water OR drinking water OR river OR lake OR pond OR wetland OR lagoon) AND (foetal growth OR foetal advancement OR foetal development OR foetal gain) as in Table 1. Only original research and observational human studies were accepted as the basis for article inclusion.

Table 1: Search Strategy

Database	Search String
Scopus	TITLE-ABS-KEY (("lithium") AND ("water" OR "surface water" OR "drinking water" OR "river" OR "lake" OR "pond" OR "wetland" OR "lagoon") AND ("fetal growth" OR "fetal advancement" OR "fetal development" OR "fetal gain"))
Web Of Science	ALL= (("lithium") AND ("water" OR "surface water" OR "drinking water" OR "river" OR "lake" OR "pond" OR "wetland" OR "lagoon") AND ("fetal "))
PubMed	((("fetal"[MeSH Terms])) AND (("growth and development"[All Fields] OR "growth"[All Fields] OR "growth"[MeSH Terms] OR "advance"[All Fields] OR "advancement"[All Fields])) AND (("surface"[All Fields] OR "surfaces"[All Fields] OR "water"[All Fields] OR "drinking water"[MeSH Terms] OR "drinking water"[All Fields] OR "rivers"[All Fields] OR "rivers"[MeSH Terms] OR "lakes"[MeSH Terms] OR "lakes"[All Fields] OR "lake"[All Fields] OR "ponds"[MeSH Terms] OR "ponds"[All Fields] OR "pond"[All Fields] OR "wetlands"[MeSH Terms] OR "wetlands"[All Fields] OR "lagoon"[All Fields] OR "lagoons"[All Fields] OR "lagoons"[All Fields] OR "water"[MeSH Terms] OR "water"[All Fields] OR "waters"[All Fields])) AND (("lithium"[MeSH Terms])))
Cochrane Library	((lithium) AND (fetal growth OR fetal development OR fetal size OR birth length OR anthropometry OR birth weight OR head circumference OR femur length))
Ovid	((lithium) AND (drinking water OR surface water OR water supply OR groundwater OR "tap water") AND (fetal growth OR fetal development OR birth weight OR birth length OR anthropometry OR head circumference OR femur length))

Reviews of a narrative, scope, or systematic nature were not accepted and were excluded from this review. Editorial papers, conference proceedings, and conference papers are intended not to be included in the article exclusion criteria, since it is likely that they will contain duplicate data from the primary research published paper. Articles that are not in English are also intended to be excluded. However, during the article searches by the three databases, no articles fulfilled the exclusion criteria. Finally, the articles that satisfied the requirements were imported into the EndNote reference manager.

M.R. or S.A. assessed the titles and abstracts of the identified articles for possibly relevant studies, and the full text was retrieved for those that passed this screening stage. We also looked for other research in the references of relevant review papers and full-text articles.

Data extraction and analysis

EndNote Reference Manager software (Clarivate, London, UK) was used to compile the articles. The selection procedure that resulted in the final number of articles included in this review is described in full in Figure 1 (PRISMA diagram) for the identification, screening, and exclusion process. After our initial search yielded 46 results, duplicate articles (n = 9) were removed by reference managers or manual search techniques during the automatic article identification phase. Ultimately, the EndNote software filtered 37 publications based on their titles and abstracts. A total of 36 articles were eliminated during the screening process for the following reasons: 1) irrelevant title (n = 22); 2) heavy metals other than Li (n = 2); 3) different context—not discussing foetal growth (n = 10); and 4) review (n = 2). After that, full text for (n=1) articles was collected. Ultimately, just one article (n = 1) was approved and featured in this review.

M.R. compiles pertinent data from chosen studies using standard tables, such as the researcher's name, the year the study was

published, the study's design, the article's title, the location, and other significant discoveries. All authors scrutinised the research findings from the publication to gather scientific proof of Li's impact on human foetal growth, which was showcased in the results section.

initiative began in October 2012. The study was observational and prospective. In this study, a mother-child cohort was established to evaluate the potential health effects of early exposure to Li and other water pollutants. All pregnant women with an expected delivery

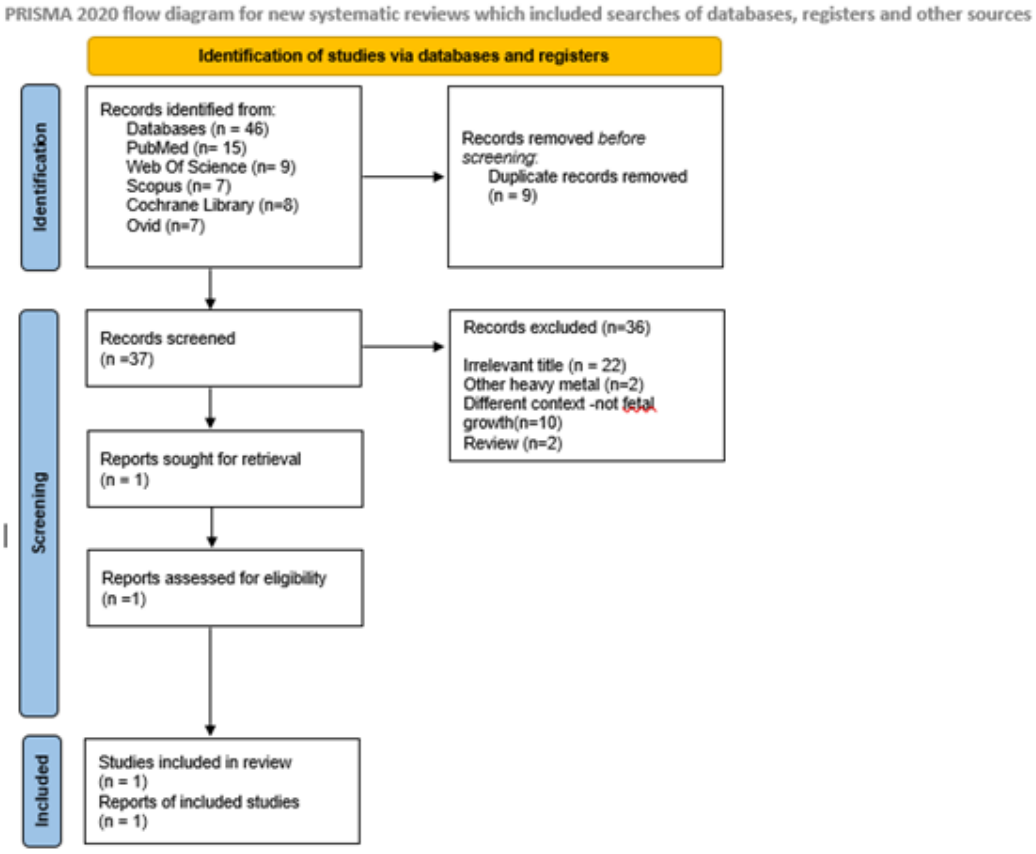

Figure 1: PRISMA Flow Diagram for Study Selection

RESULTS

This review focuses on Li's research on water pollution and its impact on prenatal development. Only one article in this study examined the effect of high Li concentration in drinking water on foetal growth and was chosen based on the screening criteria. This is probably because this review is highly focused and deals with a niche area.

Study Characteristic

The study in this review was conducted by (Harari, Langeén, et al., 2015) In Argentina, the

date between October 2012 and December 2013 were invited to participate. The research also examined the concentrations of Li in drinking water, urine, and blood to evaluate exposure. Because arsenic, boron, and caesium are also prevalent in the drinking water at the research location, the study assessed these elements in the same medium to account for any potential confounding factors. The study used inductively coupled plasma mass spectrometry (ICP-MS, Agilent 7700× ORS ICP-MS, Agilent Technologies, Tokyo, Japan) for all elements, with the collision/reaction cell set to either helium mode (arsenic) or no gas mode (Li, boron, and caesium).

A total of 180 women were successfully enrolled in the study, with the majority (68%) being over 30 years of age. Besides that, about 19% of women in the study were either overweight (BMI 25.0 to 30.0) or obese (BMI>30.0). The maximum mean concentration of urinary Li(mean=2516µg/L (1078-4598)) can be observed in women with the highest mean Li concentration in blood (mean=47(31.3-145µg/L)). The maximum mean concentration of water Li can also be observed (mean= 750µg/L (6.5-958)) in women with the highest mean Li concentration in blood (mean=47(31.3-145µg/L)). Blood and urine Li had a Spearman's correlation coefficient of 0.84 ($p<0.001$), water and blood Li of $r=0.40$ ($p<0.001$), and water and urine Li of $r=0.44$ ($p<0.001$). While urine Li increased steadily throughout gestation, blood Li increased during pregnancy, especially in the last trimester.

Relationship of Drinking Water Li Exposure and Foetal Growth

In this particular study, they found a negative correlation between maternal blood Li levels (median 25; range 1.9–145 µg/L) and urine (1645; range 105–4600 µg/L) and all foetal measurements (body, head, and femur) during the second trimester, as well as birth length (β −0.53 cm per 25 µg/L increase in blood Li, (95%CI −1.0; −0.052). A rise of 100 µg/L in blood was generally linked to a 2 cm (about one standard deviation) reduction in birth length and foetal growth.

DISCUSSION

A study in this review suggests that pregnant women who are exposed to high levels of Li in drinking water may have unfavourable effects on the development of their unborn child. Li levels in the blood and urine consistently showed inverse relationships with all foetal dimensions (head, femur, and abdomen) during the second trimester, suggesting that Li has an impact early in pregnancy. This study's findings are consistent with previous studies that observed this particular impact (Diav-Citrin et al., 2014; Källén & Tandberg, 1983; Wittström et al., 2024). Furthermore, higher levels of Li may cause suppression in foetal growth on prolonged exposure to Li medications. Although both studies relate the Li exposure to medication usage by pregnant women rather than from drinking water exposure, the similar mechanism of its toxicity on the foetus suggests that all these studies are comparable (Mohamed et al., 2023; Schrijver et al., 2024).

Surprisingly, two animal studies found different results in their offspring's weight after their paternal mice were exposed to two doses of Li during pregnancy via drinking water (Messiha, 1993; Mroczka et al., 1983). A population of mice from the initial experiment receiving a higher Li concentration had no variation in their offspring's weight. In contrast, a control experiment involving a population of mice receiving a reduced Li concentration showed a corresponding reduction in the weight of their offspring. In addition, a recent animal study also suggested that a combination of Li in the form of Lithium chloride (LiCl) with dexamethasone can also promote growth failure due to glucocorticoids. In other words, it was found in their experimental study that LiCl can stop glucocorticoids from causing rat metatarsal growth failure in vitro (Soucek et al., 2024). Therefore, this inconclusive finding requires further animal studies to understand the effect of Li on the offspring's weight.

Moreover, there are several mechanisms responsible for Li's effect on foetal development. It was found that Li's interference with the Wnt/β-catenin pathway is at the core of its effects on foetal development. This pathway regulates key processes of cell proliferation, differentiation, and apoptosis during embryogenesis.(Kurgan et al., 2019; Nery et al., 2014). Additionally, Li may also inhibit the activity of glycogen synthase kinase-3β (GSK-3β), thereby leading to dysregulation of the Wnt signalling pathway. Therefore, improper signalling via the pathway

can result in characteristic atypical cellular responses at critical points of foetal organ development, and the resultant disruption can manifest clinically in terms of structural defects or defective tissue and organ development. (Jope, 2003; Zhu et al., 2014).

Besides that, endocrine disruption is another pathway through which Li can affect foetal growth. Li may also alter thyroid hormone levels by interfering with iodine uptake and the synthesis of thyroid hormones (Ahmed et al., 2021). Since thyroid hormones are crucial for neurodevelopment and skeletal growth in the foetal period, their dysregulation can also lead to developmental delays and low birth weight (Czarnywojtek et al., 2020). Moreover, maternal hypothyroidism or subclinical thyroid dysfunction that occurs during pregnancy due to Li induction may also further exacerbate these risks (Harari, Bottai, et al., 2015).

Oxidative stress is also a significant factor playing a role in Li-induced disturbance of foetal development, whereby studies found that Li exposure can induce the generation of reactive oxygen species (ROS) and suppress the function of antioxidant enzymes, leading to damage to the developing foetus.(Allagui et al., 2009). Besides that, this oxidative stress may also compromise DNA integrity, disrupt normal cellular function, and interfere with angiogenesis(formation of new blood vessels necessary for placental function). Subsequently, poor placental function conditions can directly affect nutrient and oxygen delivery to the foetus as well as impair the foetus's growth (Liu et al., 2018).

Another explanation for this Li effect on foetal growth is through epigenetic modifications whereby Li exposure can alter DNA methylation and histone modification patterns, and finally influence gene expression in developing cells (Lee et al., 2015; Marie-Claire et al., 2021). Such epigenetic changes can also have lasting effects on the foetus, which can predispose it to developmental disorders, metabolic impairments, and growth defects. Moreover, both pharmacological and potable preparations of Li may also pass readily through the placenta and affect the thyroid, parathyroid, and cortisol hormonal systems, which are very important for foetal development(Broberg et al., 2011; Forhead & Fowden, 2014; Grandjean & Aubry, 2009; Harari et al., 2012; Newport et al., 2005). Furthermore, additional possible pathways of Li toxicity include those via vitamin D deficiency(Rosenblatt et al., 1989). One of the more recent animal studies (rats) also found that Li had effects on the developing brain and foetal development because a significant amount of Li becomes concentrated in the offspring's brain tissue. As a result, Li distribution in the developing brain is a valuable resource for investigating potential negative effects on brain development in offspring of Li drug-treated mothers(Chiou et al., 2021).

The implication of Li on foetal growth may also become a concern because of long-term impacts such as reduced mental capacity, low birth weight in the next generation, insulin resistance, and stunting in the early stages of life (Bennett et al., 2002; Broekman et al., 2009; Dewey & Begum, 2011; Grantham-McGregor et al., 2007; Kormos et al., 2014). A recent study also found that foetal growth may impact cardiac development, resulting in compensatory hypertrophy or persistent deficit in cardiomyocyte number (Masoumy et al., 2018). Foetal growth failure will also produce one of the most predominant harmful prenatal anomalies of man. It causes a significant number of premature deliveries and significantly increases the risks of perinatal death, neurological impairments, and chronic illness in adulthood. (Colella et al., 2018). Therefore, with the increasing risk of Li concentration in potable water due to pollution, the current foetal growth failure is a new, emerging, significant public health problem that warrants addressing

and demands further studies on preventive measures to combat the threat.

The contrasting findings between studies of Li exposure through medication and drinking water underscore the complexity of its effects on foetal development. For example, while therapeutic Li doses are associated with enhanced foetal growth in some cases, environmental exposure through drinking water also appears to have adverse effects. These differences may stem from varying Li concentrations, duration of exposure, and confounding factors such as co-occurring pollutants. Additionally, mechanistic pathways, including endocrine disruption and oxidative stress, may also offer plausible explanations for these outcomes. Therefore, addressing these discrepancies requires multidisciplinary collaboration between environmental scientists, toxicologists, and public health researchers.

Limitation

It is essential to recognise that this analysis has several limitations, even though it thoroughly evaluates the possible effects of Li in drinking water on foetal growth. Firstly, only one study satisfies the review's criteria, necessitating additional studies for a more comprehensive comparison. The study in this review also needs to be interpreted cautiously because it is free of biases and confounding variables that can affect foetal development, which are not considered in this study. These variables include additional toxins in drinking water, genetic predispositions, and maternal mental health considerations. Moreover, the limited number of long-term human studies that examine the long-term effects of foetal Li exposure on neurodevelopment limits the capacity to forecast wider public health ramifications.

CONCLUSION

This review highlights the growing concern surrounding Li exposure through drinking water and its potential impact on foetal development. Existing evidence indicates a negative association between Li exposure from drinking water and foetal growth. These conflicting results from recent human and animal studies further emphasise the complexity of Li's effects on foetal development, with some studies related to Li medication exposure even reporting increased foetal growth associated with Li exposure. Additionally, the long-term health implications for offspring exposed to Li in utero, primarily through contaminated drinking water, are under-researched, underscoring the need for more comprehensive studies that examine both immediate and chronic health outcomes.

CONFLICT OF INTEREST

The authors have no conflicts of interest.

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CASE REPORT

Anterior Aesthetic Rehabilitation with Injection Moulding Technique: A Case Series

Mohd Khairul Firdaus Mazlan[1,2*], Muhammad Amal Abd Wahab[2], Nazrin Rosli[3], Melati Mahmud[2]

[1] Restorative Dentistry Specialist Unit, Keningau Dental Clinic, 89009 Keningau, Sabah
[2] Centre for Restorative Studies, Faculty of Dentistry, Universiti Teknologi MARA, 47000 Sg Buloh, Selangor
[3] Centre for Comprehensive Care Studies, Faculty of Dentistry, Universiti Teknologi MARA, 47000 Sg Buloh, Selangor

*Corresponding author's email: firdausmazlan@moh.gov.my

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ABSTRACT

The injection molding technique has gained popularity for its minimally invasive and time-efficient approach in direct anterior restorations. This case series highlights three clinical cases utilizing injectable resin composite for restoring aesthetics and function in amelogenesis imperfecta, irregularly shaped teeth post-orthodontic treatment, dental caries and generalised interdental spacing. The technique, employing light-cured injectable composite, polymerized through transparent silicone index. The approach ensures optimal composite placement, accurate replication of tooth morphology, minimizes the air entrapment and enhances both the durability and aesthetics of the restoration with a strong marginal seal. The clinical time for the restoration has been considerably reduced thus enhances the patient experience. These cases demonstrate that the injection molding technique is a versatile, provides superior aesthetics, and offers predictable results for anterior direct restorations.

INTRODUCTION

Direct composite restoration is a minimally invasive procedure in restorative dentistry, widely used for its ability to restore both function and esthetics by applying composite resin directly to tooth surfaces (Paschoal et al. 2014). However, achieving optimal contour, symmetry, and natural appearance in certain anterior aesthetic cases can be challenging

with traditional freehand techniques, often requiring extensive chair time and skill, which can lead to inconsistent results (Amaro et al., 2021).

In addition to the freehand technique, other established approaches include the matrix transfer technique and palatally/ lingually guided buildups. The matrix transfer technique, while useful for replicating wax-ups, may lack adaptability during intraoral adjustments and can be limited in achieving seamless integration with surrounding dentition (Bailey et al., 2022). Palatal or lingual guidance using silicone indices provides a stable posterior framework for layering but often requires considerable layering skill to ensure proper facial anatomy, symmetry, and surface texture (Paolone G, 2014). These limitations can affect predictability and esthetic outcomes, particularly in complex anterior cases.

The injection molding technique has emerged as a promising solution to these challenges. By utilizing a specially designed silicone or transparent matrix, this method allows precise placement and contouring of composite resin (Geštakovski, 2019). The matrix guides the resin application, ensuring precise shaping, symmetry, and surface texture, overcoming the limitations of manual shaping (Machado et al., 2024). Indicated for diastema closure, Class IV restorations, veneers, erosions, abrasions, misshapen teeth, discolored teeth, composite bonding, and tooth lengthening, the technique offers superior esthetic outcomes (Terry et al., 2022). It effectively closes gaps between anterior teeth, restores fractured teeth, improves alignment and color in veneers, and repairs worn-down teeth from conditions like acid reflux or bruxism (Jabrane et al., 2024). The procedure involves case selection, impression and diagnostic wax-up, matrix fabrication, tooth preparation, resin injection, curing, and final polishing (Geštakovski, 2021). This systematic approach reduces error potential, chair time, and enhances predictability (Tekçe, 2022).

This article showcases the efficacy of injection molding through three diverse cases, highlighting its ability to address challenges in conventional methods and achieve consistent, high-quality esthetic and functional results.

CASE PRESENTATION

Case 1: Management of anterior teeth discoloration due to Amelogenesis Imperfecta

A 34-year-old male presented with concerns about the poor appearance while smiling due to discoloured upper front teeth since childhood. Similar teeth were presented with hypersensitivity exacerbated by cold drinks. He had a family history of amelogenesis imperfecta (AI) and have not received any prior treatment. Medical history was not significant. Examination revealed moderate yellow stained enamel surfaces of all teeth indicated amelogenesis imperfecta (Figure 1A). All the anterior and posterior teeth were affected with yellowish brown discolouration. From the results of clinical and radiographic evaluations indicated that the patient in the present case had hypocalcified form AI. All the teeth are misshapen, and spotted. Occlusion and vertical opening are rapidly affected by attrition. The insufficiency of the enamel makes the teeth extremely sensitive to contact and thermal stimuli (Seow, 1993). The treatment plan aimed to manage caries and tooth discoloration, improve aesthetics, and alleviate hypersensitivity. Following a detailed discussion with the patient, resin composite veneering using the injectable technique was selected for the anterior teeth. Although bonding to AI-affected enamel can be challenging due to altered enamel prism structure and reduced mineral content, predictable adhesion is still achievable, particularly when bonding is performed primarily to dentin or when enamel is selectively etched and appropriately

conditioned. Furthermore, modern adhesive systems and injectable resin composites, with their favorable mechanical properties, offer a minimally invasive yet durable restorative solution. In contrast, due to the extensive structural loss and functional demands in the posterior region, full-coverage metal-ceramic crowns were chosen to provide strength, stability, and long-term durability.

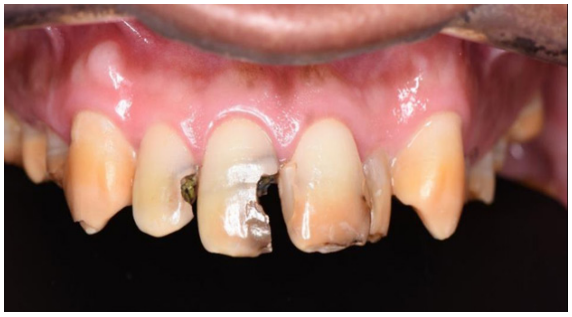


Figure 1A: Pre-operative intraoral photograph.

A diagnostic wax-up helped visualize treatment outcomes in improving the shape, contour and sizes of anterior teeth. (Figure 1B). After that, clear polyvinyl siloxane (PVS) captured the wax-up model using a non-perforated tray. A separate PVS buccal matrix guided tooth preparation was created to prevent over-reduction of the tooth structure. Equigingival margin with labial reduction of 0.5mm were done for composite veneers. This reduction was indicated due to the presence of secondary caries and intrinsic staining on the labial surfaces, necessitating removal of compromised enamel. Additionally, it allowed for the creation of adequate space for the composite material, preventing over-contouring and ensuring a natural emergence profile, optimal aesthetics, and proper periodontal health. Although the technique aimed to be minimally invasive, the labial reduction was a clinically justified compromise to enhance both the longevity and appearance of the final restorations. The clear polyvinyl siloxane (PVS) stent was tried intraorally (Figure 1C) and inciso-labial vent hole was created (Figure 1D).

Isolation with Teflon (PTFE) tape and selective enamel etching preceded application of bonding agent for adhesion (Figure 1E). The alternate tooth technique was done to confine the composite and to minimize interproximal bonding, shades wetted margins and corrected chromatic discrepancies. Injection molding was done through the stent using injectable composite, followed by excess removal and provisional finishing. Interdental and buccal finishing and polishing were done resulted in refined results.

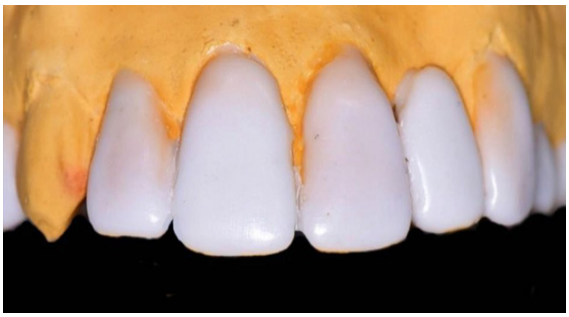


Figure 1B: A wax up is made in consultation with the patient.

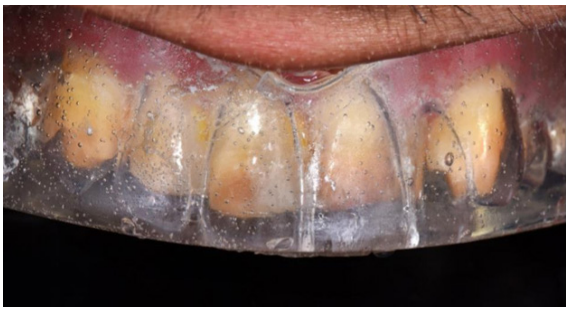


Figure 1C: Try-in EXACLEAR™ stent intraorally.

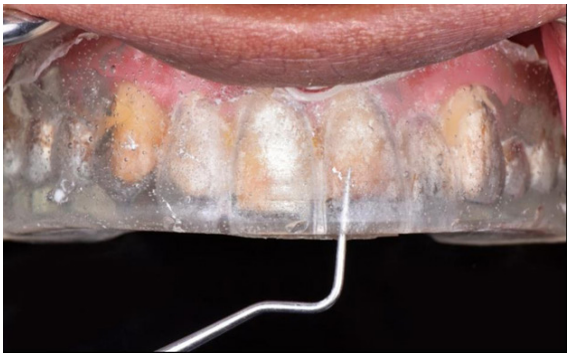


Figure 1D: Create a vent hole in the EXACLEAR™ stent with the tip of dental probe.

Patient was reviewed after six weeks to address minor adjustment and final result exhibited a glossy finish restoration (Figure 1G). Although complete masking of the underlying discoloration was not fully

achieved, there was a notable improvement in both tooth shade and morphology compared to the preoperative condition. The patient expressed high satisfaction with the aesthetic outcome. The injection molding technique was chosen over conventional direct composite layering due to its capacity to produce predictable and efficient results, especially in cases requiring full-surface coverage and morphological correction, as commonly seen in amelogenesis imperfecta. Additionally, injectable composites are particularly well-suited for anterior restorations due to their favorable mechanical properties, including high flexural strength and wear resistance,

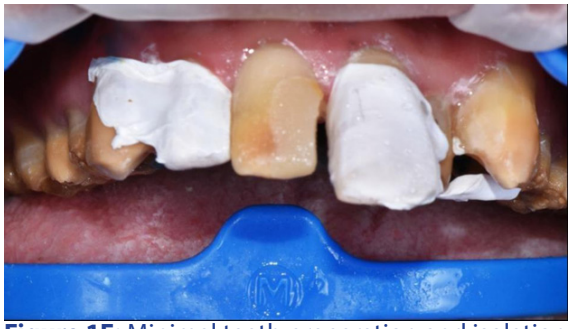


Figure 1E: Minimal teeth preparation and isolation of adjacent teeth with teflon (PTFE) tape probe.

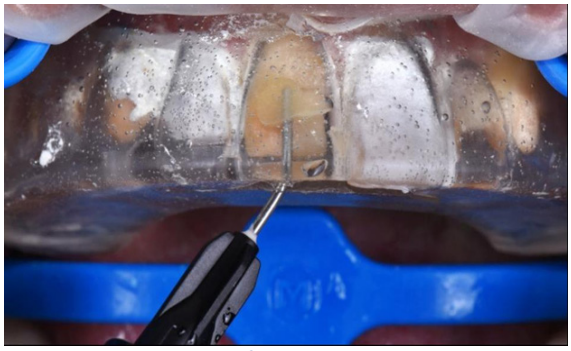


Figure 1F: Injection of composite into the transparent mould through the silicone hole

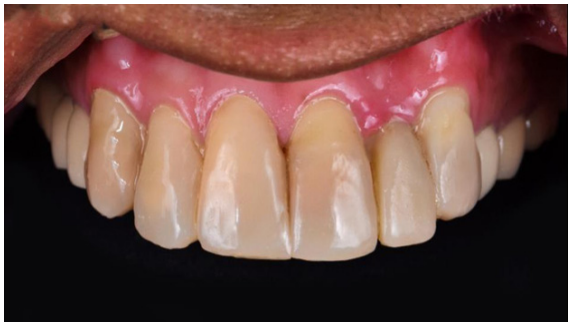


Figure 1G: Post-operative intraoral photograph.

which contribute to long-term durability and sustained aesthetic performance (Rathod et al., 2024).

Case 2: Management of Unfavorable Anterior Teeth Shape Post Orthodontics Patients

A 34-year-old female patient, dissatisfied with the irregular and disharmonious shape of her anterior teeth following orthodontic treatment. The initial assessment revealed that her central and lateral incisors had irregular shapes with black triangles presented disrupting her smile (Figure 2A).

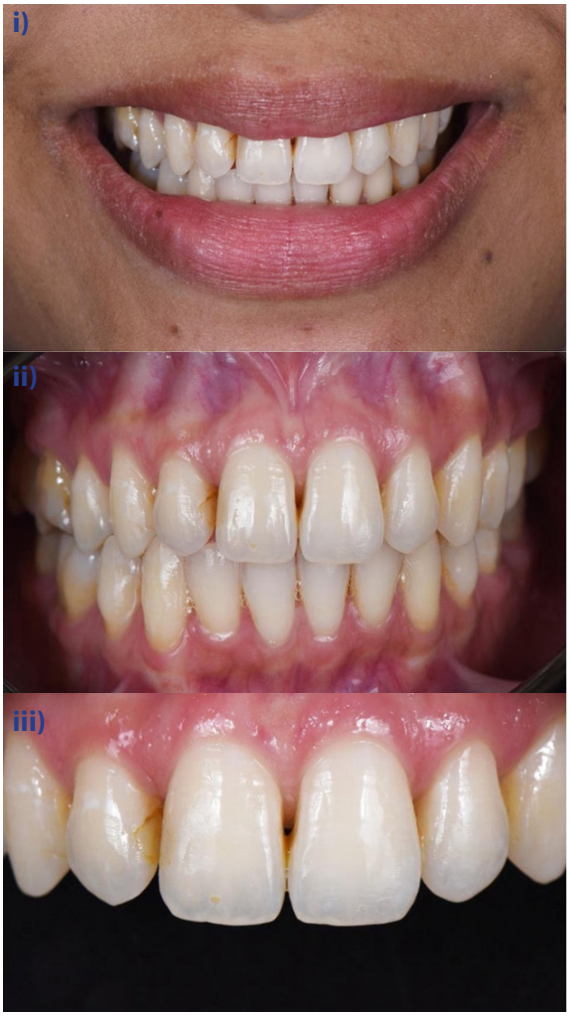


Figure 2A: Pre-operative intraoral photograph i) smile view ii) frontal view iii) closed up view.

The treatment plan focused on reshaping and contouring these teeth using injectable resin composite that is minimally

invasive. A diagnostic wax-up and clinical mock-up were performed to visualize the outcome, with adjustments made according to the operator and patient's preferences (Figure 2B). An impression was taken using clear polyvinyl siloxane (PVS) without any reduction of the existing teeth. The procedure followed steps similar to those in Case 1.

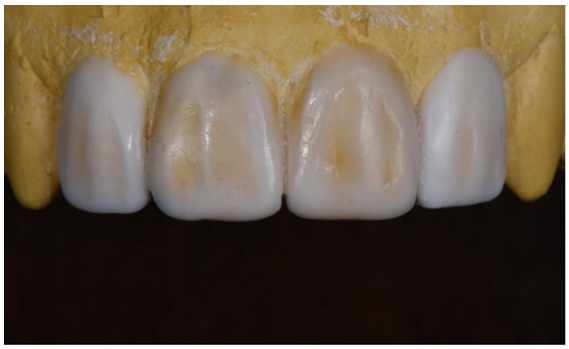
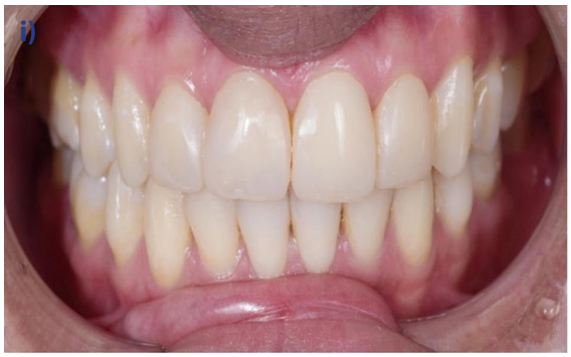


Figure 2B: A diagnostic wax up is made in consultation with the patient.

Five weeks after the initial treatment, a follow-up review was conducted to evaluate the results and make any necessary adjustments. During this review, minor adjustments and polishing were performed to refine the appearance of the veneers. The final result was a set of anterior teeth with a glossy finish that enhanced the patient's smile (Figure 2C and 2D). The patient expressed high satisfaction with the outcome, noting a significant improvement in the aesthetics of her smile.

Overall, this case highlights the effectiveness of injectable moulding techniques in addressing post-orthodontic aesthetic concerns that involves black triangles and irregular tooth shape.



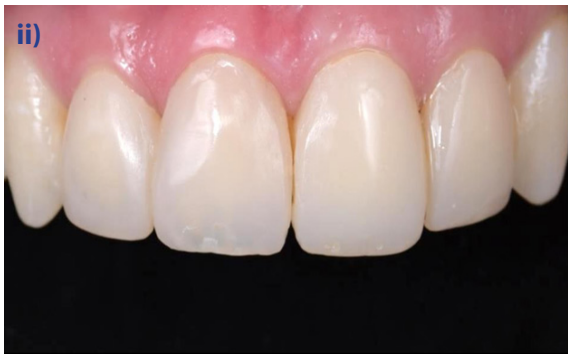


Figure 2C: Post-operative introral photo i) frontal view ii) close up view.

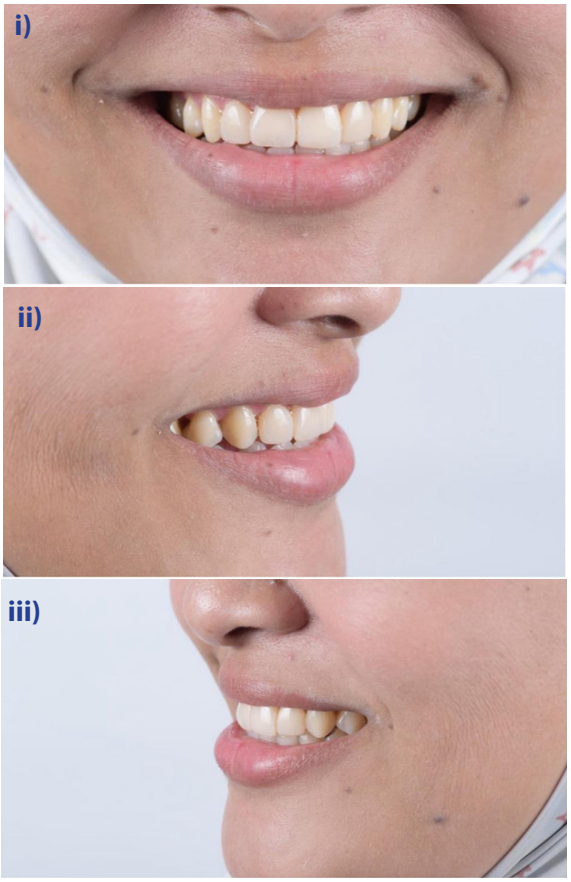


Figure 2D: Post-operative extraoral photo i) frontal view ii) right lateral view iii) left lateral view.

Case 3: Management of Anterior Teeth Spacing Post Orthodontics Patients

A 31-year-old male patient was referred from the Orthodontic Department for management of the residual anterior space following orthodontic treatment. The patient expressed concern regarding the aesthetic impact on his smile and sought an enhanced, more harmonious appearance. The initial examination revealed a generalised spacing

between the upper right and left canines, accompanied by visible brown and white discoloration attributed to fluorosis (Figure 3A and 3B).

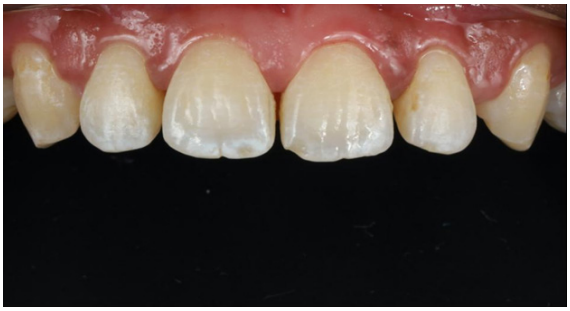


Figure 3A: Initial presentation showing localised anterior spacing with brown and white spot discolouration.

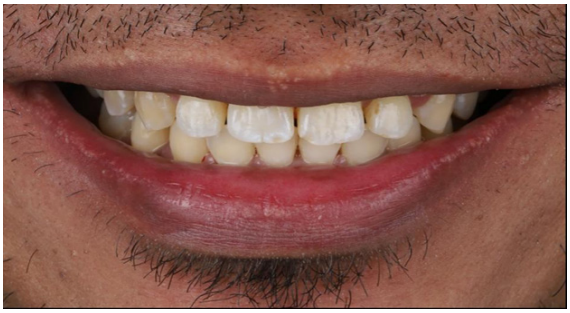


Figure 3B: Pre-operative smile view.

The treatment plan prioritized, on the reshaping and contouring of the affected teeth. A diagnostic wax-up (Figure 3C) and clinical mock-up (Figure 3D and 3E) were conducted to simulate the expected outcomes, allowing for iterative adjustments based on the patient's feedback. An impression was recorded using clear polyvinyl siloxane (PVS) without altering the existing tooth structure (Figure 3F). The treatment adhered to protocols akin to those used in a prior similar case (Figure 3G – 3K).

A follow-up assessment conducted up to one year post-treatment show intact restorations with superior outcome. (Figure 3L). The composite used in the injection moulding procedure demonstrates excellent colour stability. Minor modifications were implemented to elevate the aesthetics, yielding a refined and naturalistic finish. The patient expressed significant satisfaction, observing a marked enhancement in the appearance of his smile.

This case highlights the transformative potential of injectable moulding techniques in addressing complex post-orthodontic aesthetic challenges, showcasing a seamless integration of form, function, and patient-centered care.

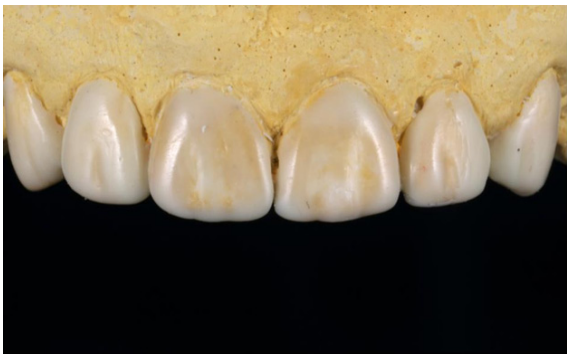


Figure 3C: Conventional laboratory wax-up.

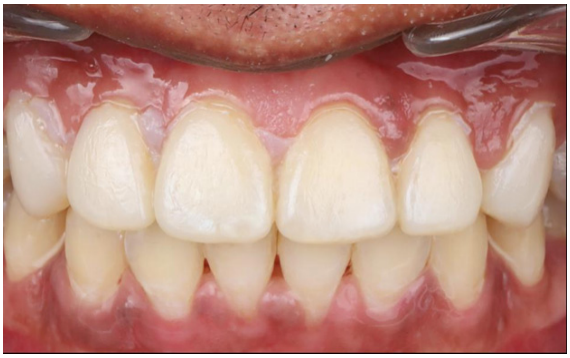


Figure 3D: Chairside mock-up using bis-acyrl material (Protemp).

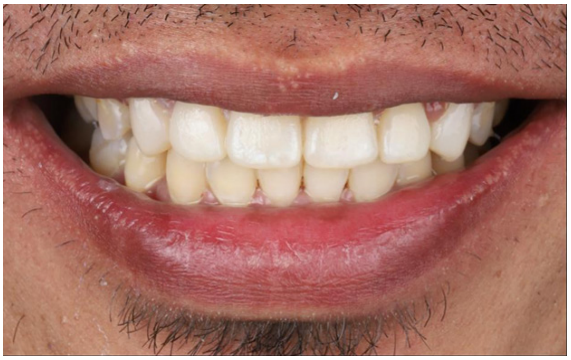


Figure 3E: Mock-up smile view.

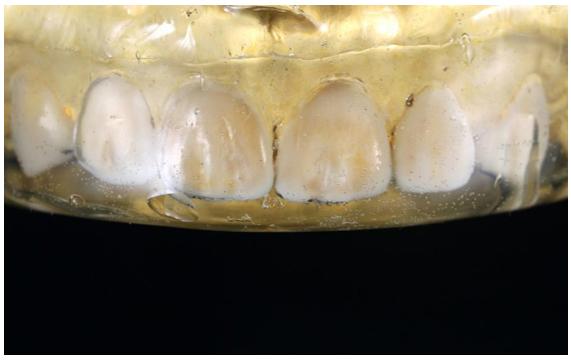


Figure 3F: Clear polyvinyl siloxane (Exaclear) adaptation to working model.

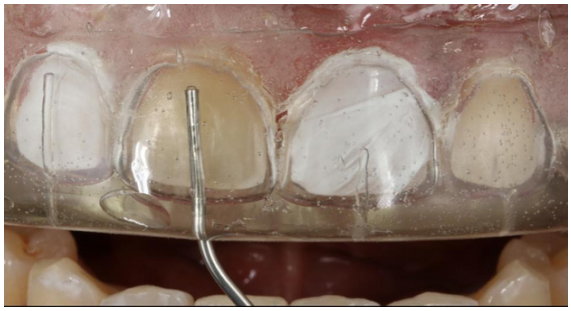


Figure 3G: Alternately teflon isolation to prevent the flow of material to adjacent tooth.

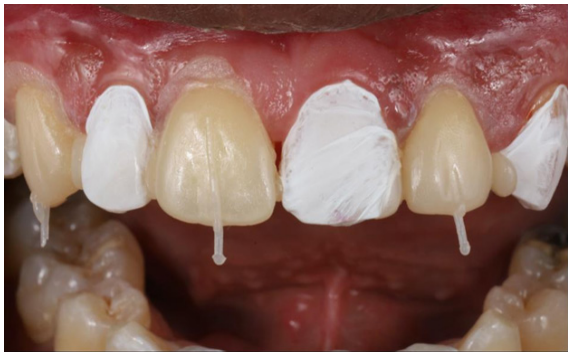


Figure 3H: After injection of flowable material.

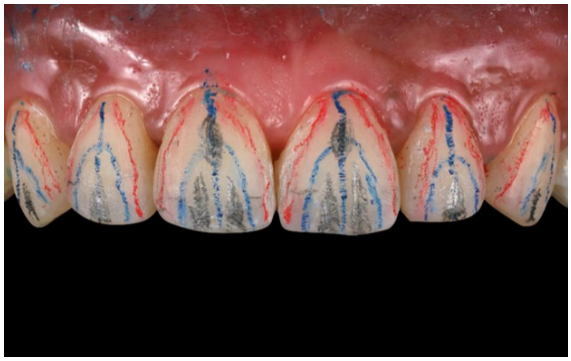


Figure 3I: Finishing phase. Primary anatomy (red line), secondary anatomy (blue line), tertiary anatomy (black line).

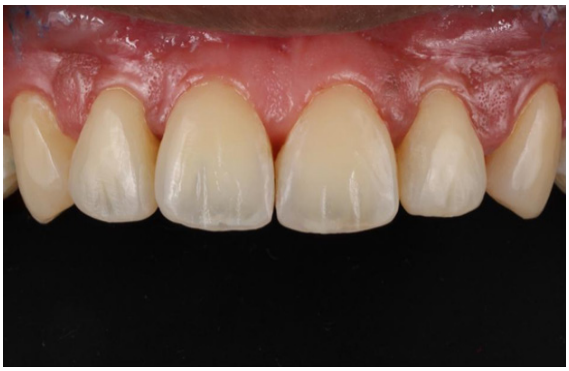


Figure 3J: Immediate post-operative finishing and polishing.

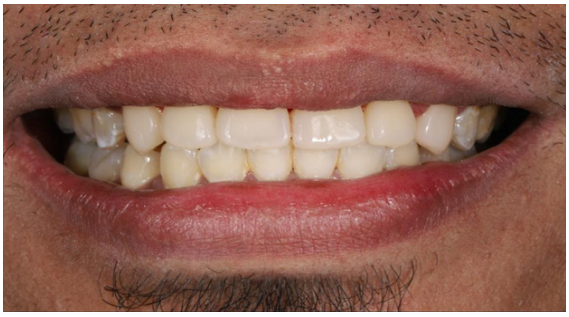


Figure 3K: Post-operative smile view.

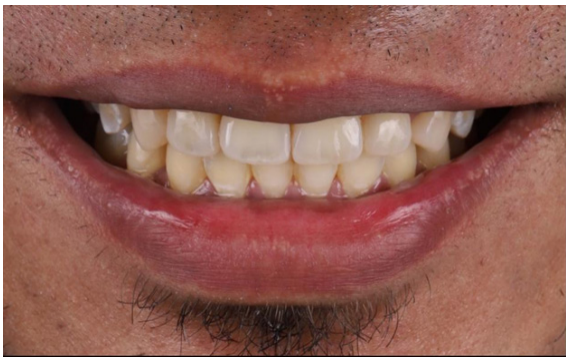


Figure 3L: 1 year post-operative review.

DISCUSSION

The injection molding technique has proven highly effective in cases requiring minimally invasive approach and aesthetically pleasing anterior restorations, as demonstrated in this case series. For complex conditions such as amelogenesis imperfecta (Case 1), the enamel irregularities and structural weakness were prevalent, the injection molding technique provides a controlled application of composite material (Tekçe, 2022). This allows for both functional and aesthetic improvements, replicating natural tooth morphology while reinforcing fragile enamel structures (Tekçe,

2016). Similarly, in cases involving irregularly shaped teeth and spacing following orthodontic treatment in case 2 and 3, the technique enables the accurate contouring and reshaping necessary to harmonize with the surrounding dentition (Terry et al., 2022). These cases underscore the suitability of injection molding for anterior restorations, particularly in patients presenting with unique morphological challenges.

The suitability of the injection molding technique in anterior restorations is further supported by the specific materials employed, clear vinyl polysiloxane and light-cured injectable composite (Ammannato et al., 2015). The extraordinary transparency allows for enhanced visualization, enabling the clinician to check every detail closely to ensure that there are no air blows or gaps around the margins (Machado et al., 2024). This transparency is particularly advantageous in cases like amelogenesis imperfecta, where accurate reproduction of tooth morphology is vital for both function and esthetics (Tekçe, 2022). Additionally, clear polyvinyl siloxane (PVS) is firm but flexible nature prevents the formation of an oxygen inhibition layer, simplifying the final polishing process and resulting in a smoother, more durable surface. Its flexibility and dimensional stability allow it to capture intricate surface details and maintain accuracy throughout the procedure, reducing the need for post-procedural adjustments (Farias Machado, 2024). In cases involving irregularly shaped teeth post-orthodontic treatment, this stability is crucial for achieving harmonious alignment and contour with adjacent teeth (Türk et al., 2024). Complementing the matrix, light-cured injectable composite offers controlled application and aesthetic versatility, essential for anterior restorations (Jabrane et al., 2024). Its flowability ensures the composite fills the matrix accurately, minimizing air entrapment and creating a seamless restoration with fewer voids (Geštakovski, 2019). Furthermore, the polishability, translucency, and color stability of light-cured composites help these restorations blend naturally with the patient's dentition, particularly in high-visibility areas (Pala et al., 2016). By facilitating precise contouring and delivering natural-looking results, these materials underscore the effectiveness of this technique in managing cases with unique morphological and aesthetic challenges (Peumans et al. 2021).

Compared to traditional non-injectable composites, injectable composites offer several distinct advantages in the context of anterior restorations. Non-injectable composites, which are typically more viscous and require incremental placement, allow for detailed manual sculpting but are often more technique-sensitive and time-consuming (Sengupta et al., 2023). In contrast, injectable composites facilitate a more streamlined and predictable application process, particularly when combined with a clear matrix system. This allows for a monolithic restoration that reduces layering errors and improves marginal integrity (Ammannato et al., 2015). Additionally, the flowability of injectable composites enhances adaptation to the cavity or matrix, minimizing the risk of voids and improving the longevity of the restoration (Ypei Gia et al., 2021). However, traditional composites may still provide superior mechanical properties in term of higher wear resistance and stiffness, which leads to making them more preferable in high-load bearing posterior areas (Ilie & Hickel, 2009). Therefore, while injectable composites are highly suited for anterior aesthetic cases where contouring and translucency are paramount, clinicians should carefully assess the functional demands of each case when selecting the material.

Despite its advantages, the injection molding technique is not without limitations. One primary concern is the technique sensitivity; a precise workflow is essential to avoid errors such as incomplete polymerization, air entrapment, or marginal overhangs. Operator experience significantly influences

the outcome, particularly in maintaining the correct pressure during injection and achieving complete curing through the transparent matrix. Furthermore, the material's flowability, while beneficial for adaptation, may result in slight overextensions if not properly managed. Another key challenges in the injection molding technique is achieving adequate isolation, which is essential for the success of adhesive restorative procedures. Contamination with saliva, crevicular fluid, or blood during bonding can significantly compromise the integrity and longevity of the restoration. While rubber dam placement is ideal, it may be impractical in certain clinical situations, particularly when restoring multiple anterior teeth or when dealing with altered tooth morphology, such as in amelogenesis imperfecta (Koppolu et al., 2012). In the present cases, effective isolation was achieved using a combination of a flexible cheek retractor, high-volume saliva ejector, and strategically placed cotton rolls. The use of cotton rolls is particularly advantageous in anterior regions, where they can both displace the lip and absorb saliva in the maxillary anterior vestibule. Notably, their use is more prevalent in anterior (46%) compared to premolars (36%) and molars (32%), highlighting their utility in achieving effective isolation in the anterior region (Lawson et al., 2015). This approach provided sufficient moisture control and soft tissue retraction, enabling reliable adhesion and accurate composite placement without compromising access or visibility.

The success of the injection molding technique is closely tied to the physical properties of the composite resin used. A key requirement is optimized flowability, which allows the material to accurately fill the transparent matrix without trapping air, ensuring seamless adaptation to tooth surfaces and intricate anatomical details (Jabrane et al., 2024). Injectable composites typically have a lower viscosity compared to traditional packable composites, enabling more precise delivery through syringes or dispensers under controlled pressure. Despite their fluid nature, these materials are formulated to possess sufficient thixotropy, meaning they become less viscous under shear stress but return to a more stable state once the stress is removed. This property helps maintain their shape after injection. In addition to flow characteristics, polymerization behavior is critical. Light-cured injectable composites used in injection molding must exhibit a high degree of conversion upon curing to ensure optimal mechanical properties and long-term stability. A high degree of monomer conversion reduces residual monomers, which can compromise biocompatibility and physical strength. Furthermore, many modern injectable composites incorporate nano-hybrid or nano-filled technology, which improves wear resistance and enhances mechanical properties such as flexural strength and surface hardness, which the traits essential for withstanding functional stress in the anterior region (Ilie & Hickel, 2009).

Given its potential, the injection molding technique can be a valuable tool for clinicians, particularly in managing aesthetic challenges in the anterior region. To maximize outcomes, it is recommended that clinicians should undergo adequate training to master the workflow, especially in matrix fabrication, material handling, and light curing. Case selection be guided by clinical indications, reserving this technique for cases where minimal invasiveness, aesthetics, and morphologic control are paramount. Long-term clinical studies be conducted to evaluate the durability, color stability, and patient satisfaction associated with injectable composites compared to traditional restorative methods. Moreover, exploring the biomechanical behavior and wear resistance of newer generations of injectable composites could provide insights for broader clinical applications, including use in posterior teeth or full-arch reconstructions.

CONCLUSION

This case series underscores the advantages of the injection molding technique for direct anterior restorations, especially in managing complex cases like amelogenesis imperfecta and post-orthodontic reshaping and complications. The technique provides precision in composite placement, ensuring a strong marginal seal and minimizing risks of air entrapment, while also enabling accurate replication of natural tooth morphology with minimal finishing and polishing. Importantly, this approach reduces chairside time, offering efficiency for both clinician and patient without compromising aesthetic and functional outcomes. Overall, these cases demonstrate that the injection molding technique is a reliable, time-efficient, and aesthetically superior approach for anterior direct restorations, making it a valuable option in contemporary restorative dentistry.

CONFLICT OF INTEREST

The authors affirm that they have no conflicts of interest, whether financial or of any other nature.

CONSENTS

Informed consent was obtained from all patients before preparing this case report.

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CASE REPORT

Dental Aesthetics and Functional Rehabilitation in a Case of Reinfection and Tooth Loss: A Case Report

Mohd Khairul Firdaus Mazlan[1,2], Siti Mariam Ab Ghani[2], Muhammad Amal Abd Wahab[2]

[1] Restorative Dentistry Specialist Unit, Keningau Dental Clinic, Keningau, Sabah, Ministry of Health , Malaysia
[2] Centre for Restorative Studies, Faculty of Dentistry, Universiti Teknologi MARA, Sg Buloh, Selangor

*Corresponding author's email: firdausmazlan@moh.gov.my

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ABSTRACT

In this clinical report, a 41-year-old Malay female patient presented with reinfection of her root treated central incisor teeth. There was a significant loss of coronal tooth structure in the maxillary anterior teeth and missing posterior teeth requiring a restorative solution. A combination of conventional prosthodontic techniques and a digital workflow was employed for optimal outcomes. To address the loss of coronal tooth structure, indirect all-ceramic restorations with post core were chosen. These restorations offer excellent aesthetics and durability, closely resembling natural teeth. The utilization of digital technology ensured precise measurements and fabrication, resulting in restorations that fit accurately and function optimally. For the bilateral missing teeth in the first molar region that has impacted the patient's ability to chew effectively, implant-supported crowns were provided to restore the masticatory performance. Dental implants provided a stable foundation for the crowns, improving chewing efficiency and overall oral function. The treatment approach successfully restored both aesthetics and functionality, significantly enhancing the patient's quality of life. Regular follow-up visits and maintenance protocols were implemented to ensure long-term success.

INTRODUCTION

Restoring endodontically treated teeth (ETT)

remains a clinical challenge and a topic of ongoing debate in contemporary dentistry (Caussin et al., 2024). Restoring pulpless teeth requires a careful approach to maintain the biomechanical integrity and longevity of the restoration while achieving functional and aesthetic outcomes (Rathee et al., 2023). One key factor in the clinical success of these restorations is the preservation of coronal tooth structure, which plays a vital role in sustaining the tooth's adhesive, functional, and aesthetic balance (Naumann et al., 2018).

Advancements in adhesive dentistry and restorative materials have broadened the options for reinforcing and protecting ETT (Caussin et al., 2024). These developments offer a conservative means to enhance the structural resilience of ETT while closely approximating the mechanical properties of natural dental tissues (Bhalla et al., 2020). For cases where minimal coronal structure is lost, directly bonded restorations are often effective, providing short-term solutions that support structural stability without the need for extensive intervention (Mannocci et al., 2022). In contrast, teeth with moderate to significant coronal loss may benefit more from indirect restorations, which, when combined with appropriate adhesive techniques, can provide the necessary reinforcement for long-term functionality (Chrepa at al., 2014).

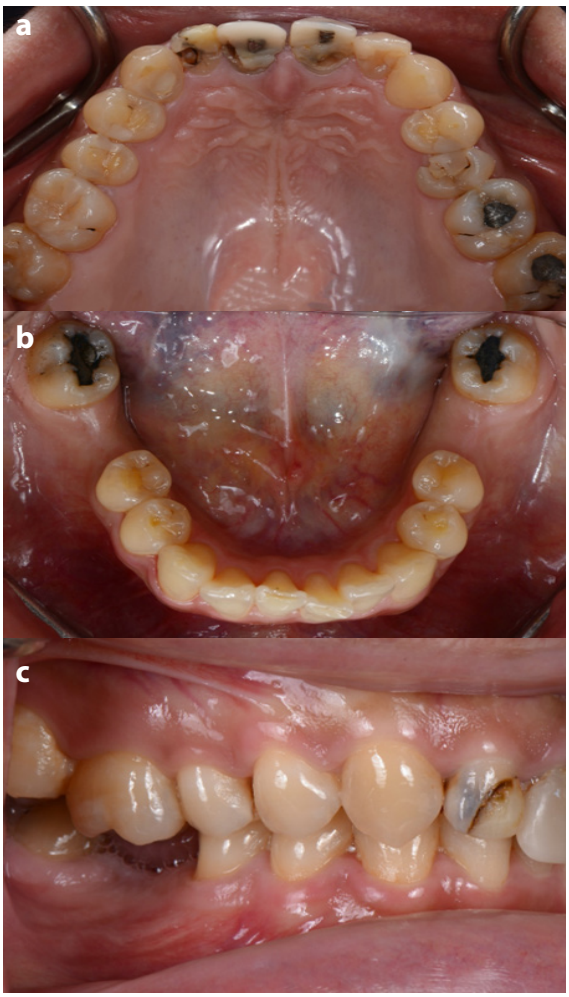
This clinical report describes the use of both conventional and digital prosthodontic approaches to restore a case of reinfected root-treated central incisors with substantial coronal tooth loss. Additionally, it addresses the masticatory challenges posed by missing posterior teeth through implant-supported restorations. The treatment strategy aimed to restore both aesthetic and functional aspects, thereby enhancing the patient's quality of life and delivering a robust and enduring solution.

CASE PRESENTATION

The patient, a 41-year-old Malay female, presented with swelling and pus discharge from her upper front teeth. She had previously been referred by a general dentist due to failed root canal treatments on teeth 11 and 21, completed three years prior. Approximately a year after the initial treatment, she began experiencing intermittent swelling in this area, though it was not accompanied by pain.

On clinical examination, the patient was found to be partially edentulous in the lower arch, with multiple heavily restored teeth and missing bilateral mandibular first molars (Figure 1). Teeth 11 and 21 were restored with composite and metal posts, both of which had developed secondary caries under the composite (Figure 2). These teeth were also tender to percussion and palpation.

Radiographs revealed posts in both 11 and 21 with deficient obturation material and



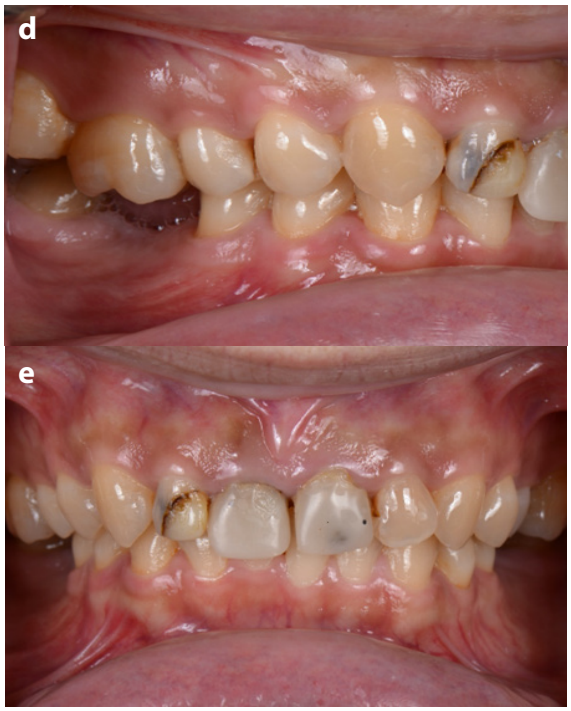


Figure 1: Intraoral pre-operative picture. a) maxillary arch b) mandibular arch c) right buccal view d) left buccal view e) frontal view

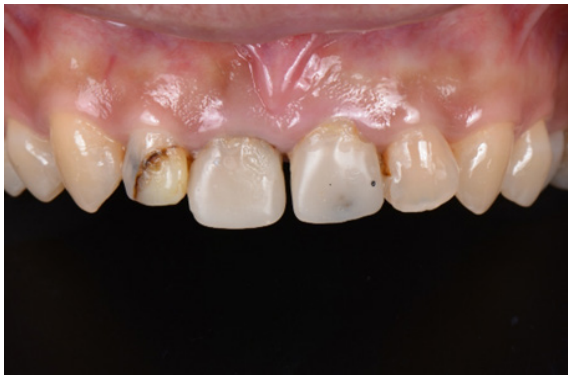


Figure 2: Area of presenting complaint

periapical radiolucency at the root of tooth 21, suggesting a chronic infection. Radiolucencies were also observed on adjacent teeth (12, 22, and 25), indicative of secondary caries (Figure 3). Teeth 13, 11, and 21 was root treated.

After removing the existing restorations and metal posts on teeth 11 and 21, secondary caries were detected and removed. A ferrule of 2 mm height and 1 mm circumference was achieved on tooth 11, and 4 mm height with 1.5 mm circumference on tooth 21, meeting the minimal structural requirements for restorability (Figure 4).

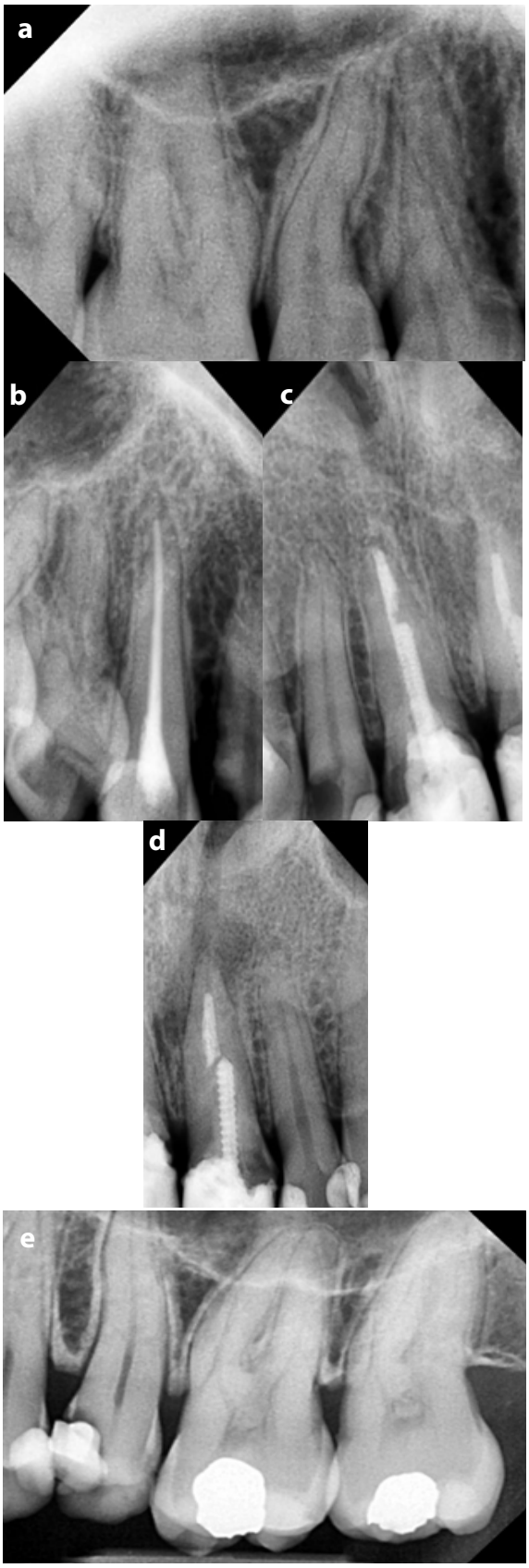
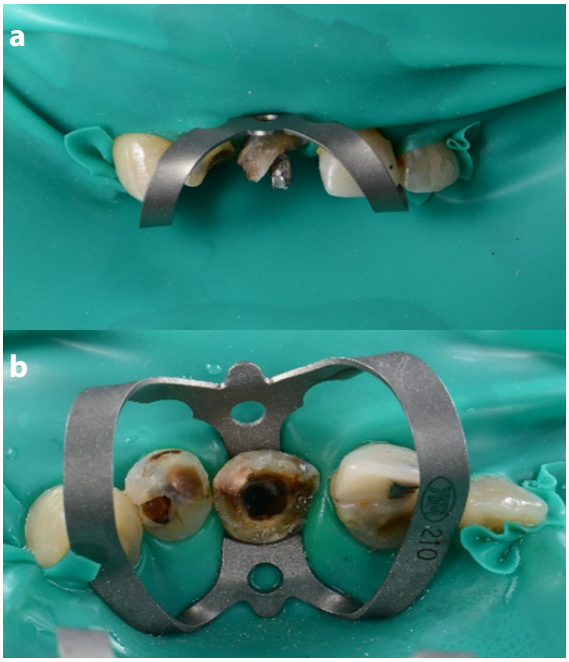


Figure 3: Periapical radiograph. a) teeth 16-15 b) teeth 14-13 c) teeth 12-11 d) teeth 21-22 e) teeth 23-27

Primary impressions were taken using irreversible hydrocolloid material (Figure 5), and study models were fabricated for diagnostic purposes. Facebow transfer and interocclusal records were taken, and the study casts were mounted on a semi-adjustable articulator. A conformative approach was planned, with a wax-up to help the patient visualize the treatment outcome, and a diagnostic setup confirmed adequate restorative space (Figure 6). Canine guidance was planned for excursive movements following the existing occlusal scheme.

The diagnosis included dental biofilm-induced gingivitis on a normal periodontium, chronic apical abscess on previously treated 11 and 21, and a partially edentulous mandibular arch. Treatment began with removal of infected obturation material on 11 and 21, followed by diet counseling, oral hygiene instruction, fluoride therapy, and non-surgical periodontal therapy. Direct composite restorations were placed on 12 and 22.

During the pre-prosthetic phase, endodontic retreatment on teeth 11 and 21 involved thorough cleaning and shaping of the canals, followed by disinfection with 5% sodium hypochlorite (NaOCl). To ensure an optimal seal, an apical plug of mineral trioxide aggregate (MTA) (Endo-eze MTA Flow, Ultradent) was placed 5 mm into each canal (Figure 7). The protocol for constructing a direct anatomical post involved several steps (Figure 8). First, the posts are cleaned with 37% phosphoric acid and applying a thin layer of



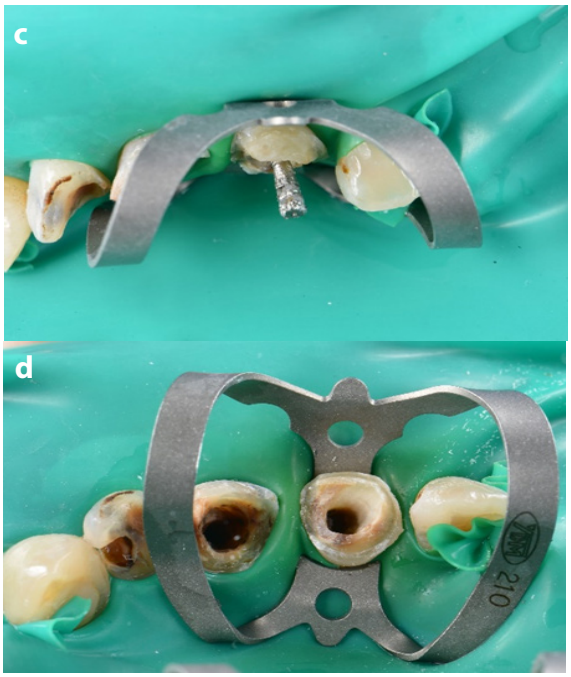


Figure 4: Access restorability a) and b) tooth 11 c) and d) tooth 21

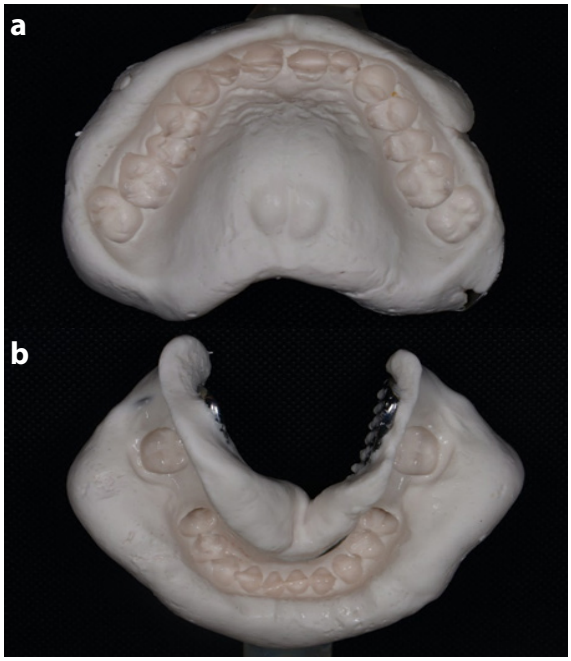
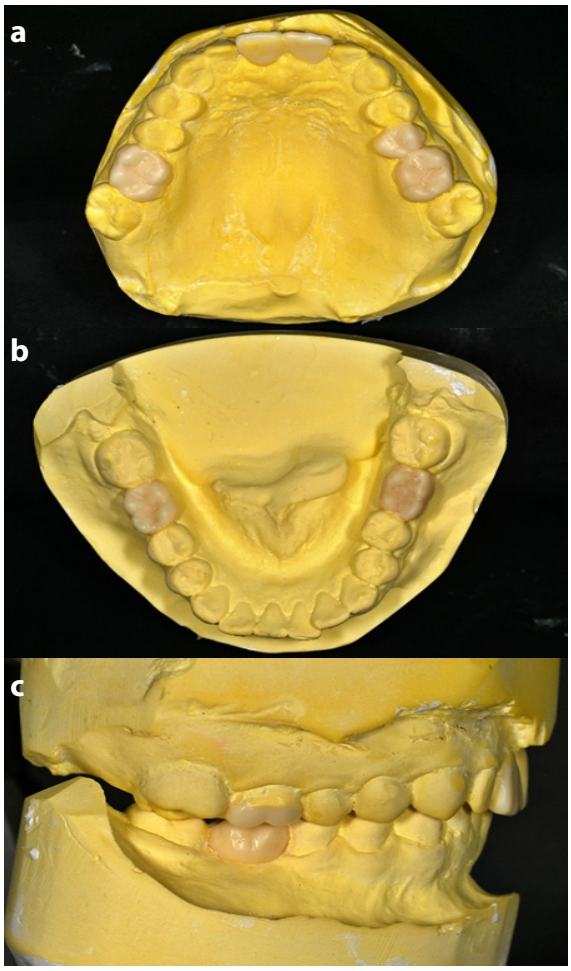


Figure 5: a) maxillary primary impression b) mandibular primary impression

adhesive. After isolating the root canal with a glycerine-based gel and micro brush, a micro-hybrid composite resin was introduced, and the main fiber glass post, along with accessory posts, was positioned within the canal. An initial photo-activation of 10 seconds was performed, followed by extra-oral curing of the post for an additional 40 seconds. The post was then treated with phosphoric acid and adhesive, while the root canal was conditioned and dried. A dual resin cement was used to bond the anatomical post to the canal, and after excess cement was removed, a composite core was created and cured. Following this, the tooth was prepared for the final prosthesis.

For implant placement in the edentulous mandibular regions at sites 36 and 46, a clinical and radiographic evaluation confirmed adequate bone width and height. The Cone Beam CT scan, taken with a radiographic stent, showed sufficient bone



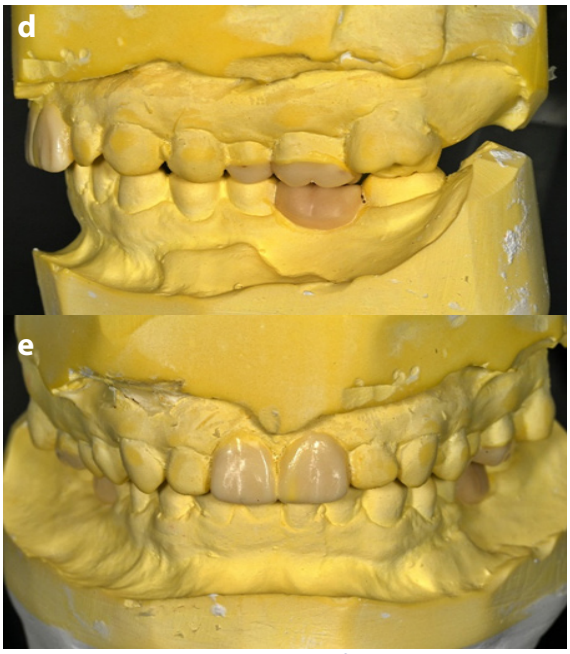


Figure 6: Diagnostic wax-up of study model mounted on semi-adjustable articulator . a) left buccal view b) frontal view c) right buccal view d) maxillary occlusal view e) mandibular occlusal view

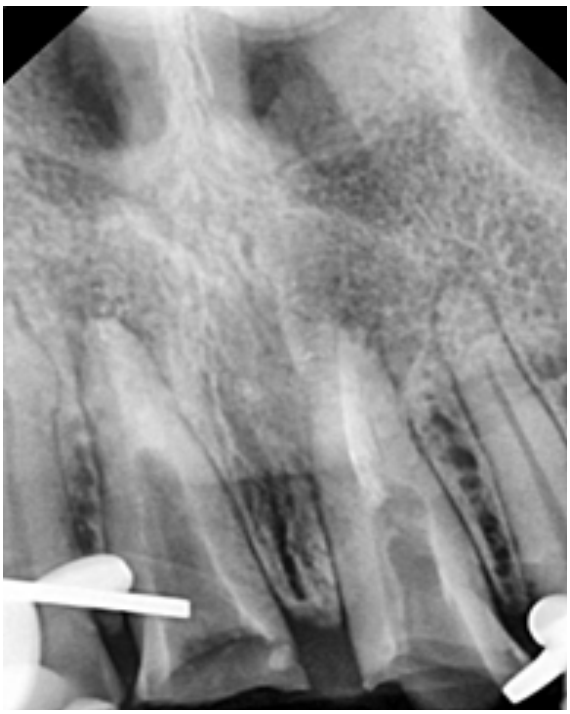
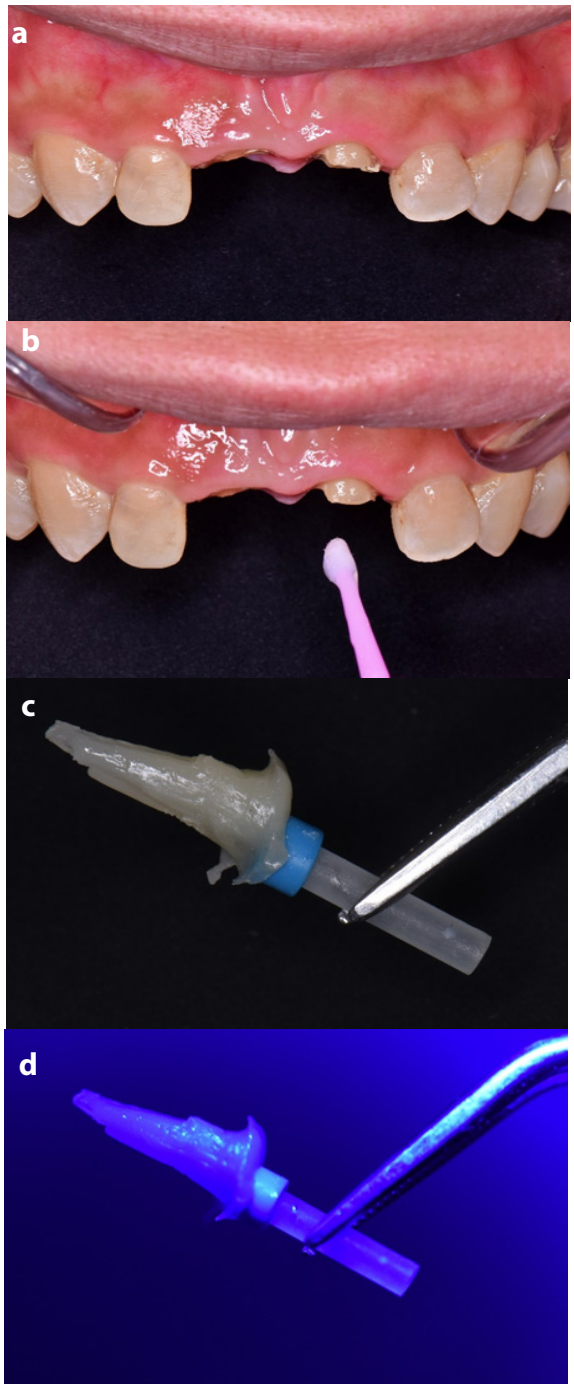


Figure 7: Obturation with MTA plug

availability to support 10 mm implants (Figure 9). During surgery, a mid-crestal, full-thickness mucoperiosteal flap with a relieving incision was made. A ø 4.5 x 10 mm Anyridge® (Megagen, South Korea) implant was placed at

site 36 and 46, using a surgical guide (Figure 10). Cover screws were positioned post-placement, and sutures were removed after one week, with healing progressing well after four weeks. Two months post-placement, a second-stage surgery was performed to replace the cover screws with healing abutments (Figure 11).

In the definitive prosthodontic phase, full coverage monolithic lithium disilicate restorations were designed for teeth 11 and



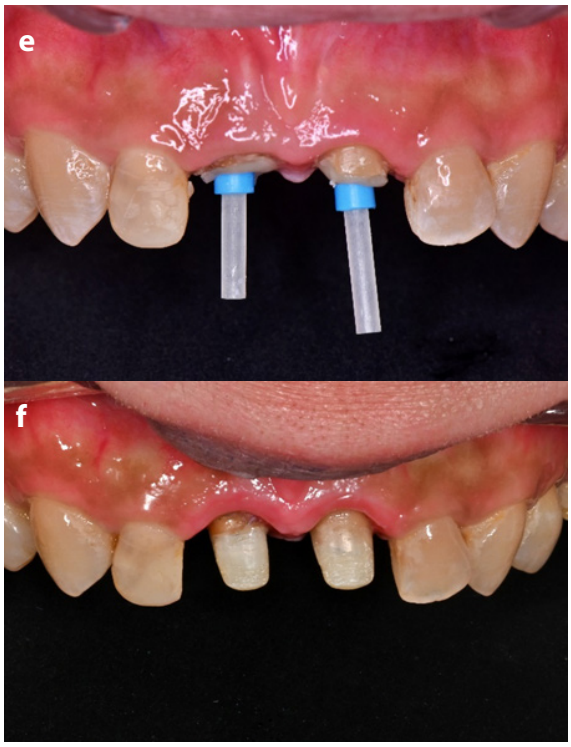


Figure 8: a) Cleaning of the posts after root canal treatment b) isolation of the root canal with a glycerine-based gel c) removal of the anatomical post after fitting in root canal d) complementary extra-oral photo-activation e) cementation of direct anatomical post f) teeth preparation.

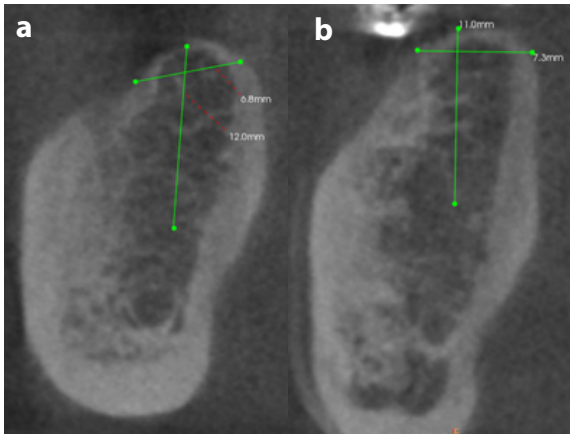


Figure 9: Cone Beam CT scan of bone dimension a) 46 site b) 36 site

21, while partial coverage restorations were fabricated for teeth 16, 25, and 26. Zirconia implant-supported crowns were designed for sites 36 and 46. Teeth were prepared based on the prosthesis design, and intraoral digital impressions and bite registrations were obtained (Figure 12). Using CAD/CAM

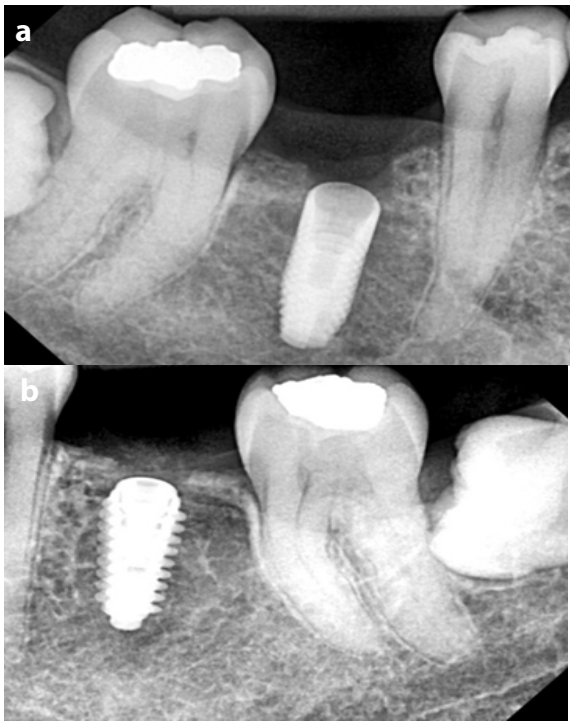


Figure 10: Periapical radiograph post-implant placement a) tooth 46 b) tooth 36

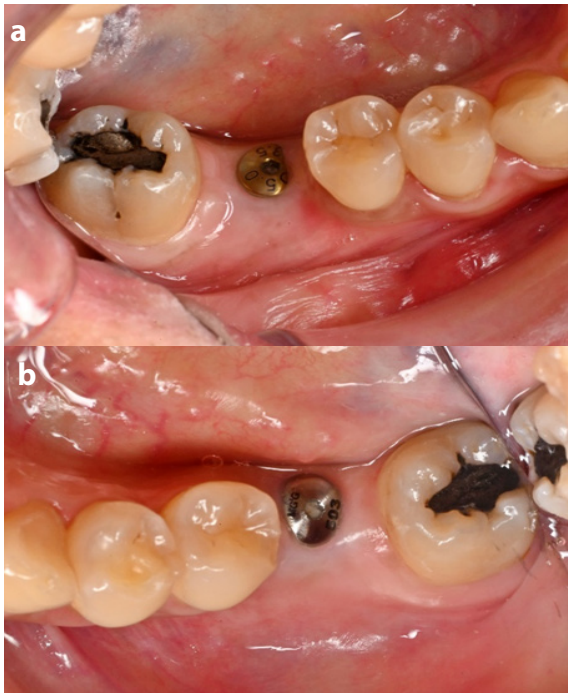


Figure 11: Placement of healing abutment a) tooth 46 b) tooth 36

technology, custom restorations were designed and fabricated, culminating in the delivery of all final prostheses to restore the patient's function and aesthetics (Figure 13).

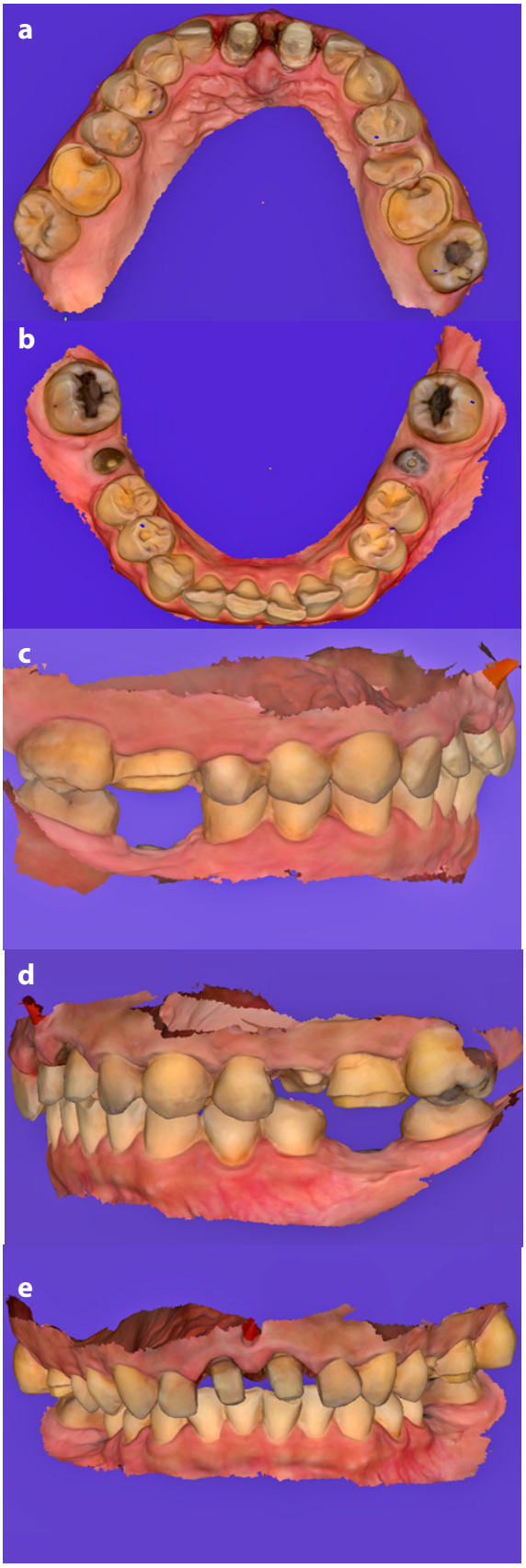


Figure 12: Digital Intraoral impression a) maxillary arch b) mandibular arch c) right buccal view d) left buccal view e) bite registration

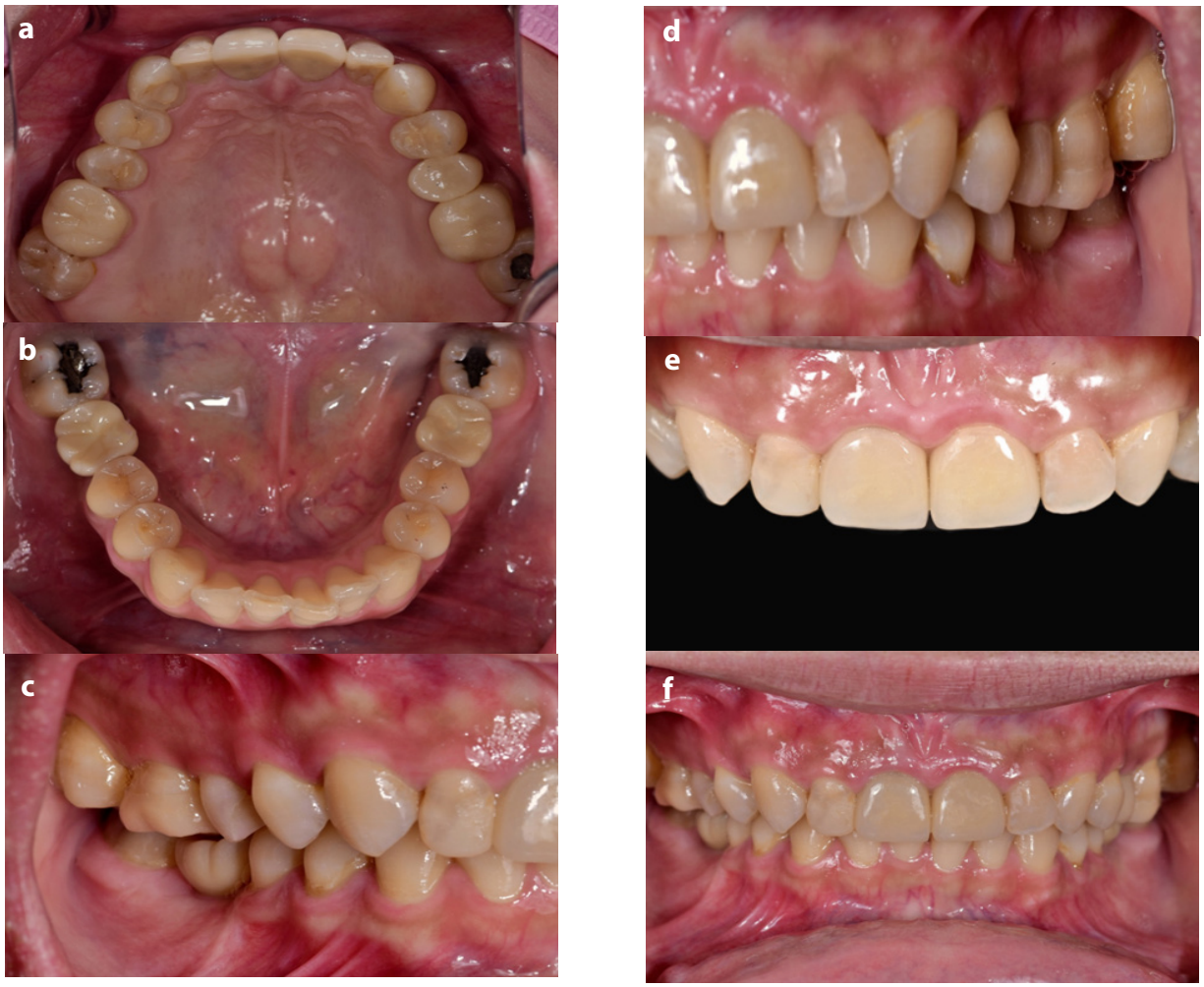


Figure 13: Intraoral post-operative picture. a) maxillary arch b) mandibular arch c) right buccal view d) left buccal view e) frontal view f) area of presenting complaint

Finally, a maintenance phase was established with follow-ups scheduled one week after prosthesis delivery and every six months thereafter.

DISCUSSION

The assessment of tooth restorability is a critical step in treatment planning, particularly for structurally compromised teeth. One of the most vital determinants is the amount of remaining sound tooth structure especially dentin, since it directly influences the success and longevity of the final restoration (Kutesa-Mutebi & Osman, 2004). Clinical evidence suggests that a remaining dentin thickness greater than 1 mm is generally favorable, with the buccal and palatal walls contributing more significantly to the mechanical stability of the restoration compared to the mesial and distal aspects (Stankiewicz & Wilson, 2008). When insufficient coronal structure exists, a post and core restoration may be considered, but only when it can be justified biomechanically and biologically (Bhalla et al., 2020). Periodontal health is integral to successful outcomes; inflammatory changes induced by compromised restorations or microbial invasion can further deteriorate the remaining tooth structure (Kois, 2000). Endodontic considerations are equally significant, particularly in teeth that have undergone or require root canal treatment. A secure apical seal is necessary to prevent reinfection, and the clinician must assess whether additional endodontic intervention

may exacerbate the existing compromise or introduce new risks (Mannocci et al., 2014). Occlusal factors also influence restorability. Functional loading, especially in posterior teeth or those subject to excessive occlusal forces, must be evaluated, as highlighted in a recent study, which emphasizes that occlusal loading on endodontically treated teeth can significantly affect structural integrity (Mazlan et al., 2025). Parafunctional habits like bruxism must be identified and managed, as they impose repetitive stresses that may accelerate failure of both the restoration and the tooth itself (Popescu et al., 2025).

A comprehensive restorability assessment should follow a structured protocol, beginning with the removal of all existing restorations and thorough excavation of caries. This is followed by an evaluation of the periodontal condition and its potential for recovery. Finally, the assessment should consider the tooth's strategic importance, esthetic relevance, and functional role within the occlusal scheme (Adawi & Dewan, 2025). To aid clinicians in making such complex decisions, the Dental Practicality Index (DPI) has recently been introduced as a clinical tool to evaluate the feasibility and prognosis of restorative procedures. The DPI provides a standardized approach to guide treatment decisions, including when to proceed with restoration, when to monitor, and when to refer the patient for specialist care (Dawood & Patel, 2017). This holistic approach ensures that restorability is not judged solely on remaining structure, but also considers biological, functional, and practical clinical parameters.

The placement of crown margins plays a critical role in both periodontal health and restorative success (Nugala et al., 2012). Equigingival margins, which align with the crest of the gingiva, were traditionally discouraged due to concerns over increased plaque accumulation and the potential for gingival inflammation compared to supragingival. Additionally, the possibility of gingival recession exposing the crown margin was seen as an esthetic risk. However, advances in restorative materials and techniques have addressed many of these concerns (Khuller & Sharma, 2009). Today, equigingival margins can be finished to a smooth, polished surface that integrates esthetically and functionally with the tooth, making them more acceptable from a periodontal perspective (Nugala et al., 2012). Studies have shown that both supragingival and equigingival margins are generally well tolerated by the periodontium when executed properly. Equigingival margins pose minimal risk to the biological width when properly placed (Alqahtani et al., 2019). It has been shown that maintaining a 3 mm distance between the preparation margin and the alveolar bone is essential to preserve periodontal health over a period of 4 to 6 months. This 3 mm encompasses approximately 1 mm of supracrestal connective tissue attachment, 1 mm of junctional epithelium, and 1 mm for the gingival sulcus, thereby providing sufficient space for biologic width even when the margin is placed 0.5 mm within the sulcus (Jorgić-Srdjak et al., 2000). In contrast, subgingival margins are more likely to encroach upon the attachment apparatus, potentially triggering inflammation, attachment loss, or gingival recession. Even when not overtly violating the biologic width, subgingival placement may still provoke adverse tissue responses merely due to its subgingival location (Alqahtani et al., 2019). Therefore, equigingival margins, when executed with precision, appropriate contouring, and proper spatial respect for the biologic width, offer a biologically safer and esthetically sound option for crown construction, particularly when subgingival placement is not indicated.

Post and core restorations are often needed for teeth with moderate-to-extensive loss of tooth structure in order to retain the crown. The choice of post depends on the amount of remaining coronal tooth structure (Bhalla et al., 2020). Fibre posts are recommended when there is enough

coronal dentin, while cast posts are suitable for moderate-to-severe tooth structure loss (Bacchi et al., 2013). However, a review of laboratory and clinical studies showed that endodontically treated posterior teeth with limited tissue loss can be restored without posts, especially when total coverage is planned (Aurélio et al., 2016). Another review found insufficient evidence to support or reject the use of posts in cavities without remaining walls and with a circumferential ferrule of 2 mm in height and 1 mm thick. Clinical decision-making should consider factors such as remaining tooth structure, tooth type and position, occlusal and functional requirements, and the type of final restoration (Naumann et al., 2018). In terms of post selection, a recent review and meta-analysis concluded that fibre posts have higher survival rates than metal posts in restoring teeth with no more than two remaining walls (Wang et al., 2019). The current case report chose the fibre post over metal post for the restoration of anterior teeth. This is because fibre posts, with similar elastic moduli to dentin (20 GPa), distribute stress more effectively compared to metal posts (200 GPa), which concentrate stress at the apical region and can lead to root fractures (Rocca & Krejci, 2013).

The choice of final restoration depends on the amount and quality of remaining tooth structure, topography and coronal morphology of the tooth and the functional occlusal forces that the restoration-tooth complex has to withstand (Vârlan et al., 2009). Furthermore, protecting endodontically treated teeth with appropriate prostheses is essential, as they are subjected to higher occlusal forces than vital teeth (Mazlan et al., 2025). The use of partial coverage restorations allows the clinicians to preserve dentin and when this conservation approach is combined with the use of correct adhesive protocols, it can provide long-lasting aesthetic restorative management for ETT (Mannocci et al., 2014). The recommendations for the restoration of endodontically treated anterior teeth are illustrated in Figure 14 which was adapted according to Bhalla et al., 2020.

CONCLUSION

Preserving coronal tooth structure is essential for success, with adhesive dentistry advancements enabling conservative options for ETT. Direct restorations suit minimal tooth loss, while indirect restorations and post and core systems address more extensive loss. Fibre posts are preferred for anterior teeth and adequate dentin, as they better distribute

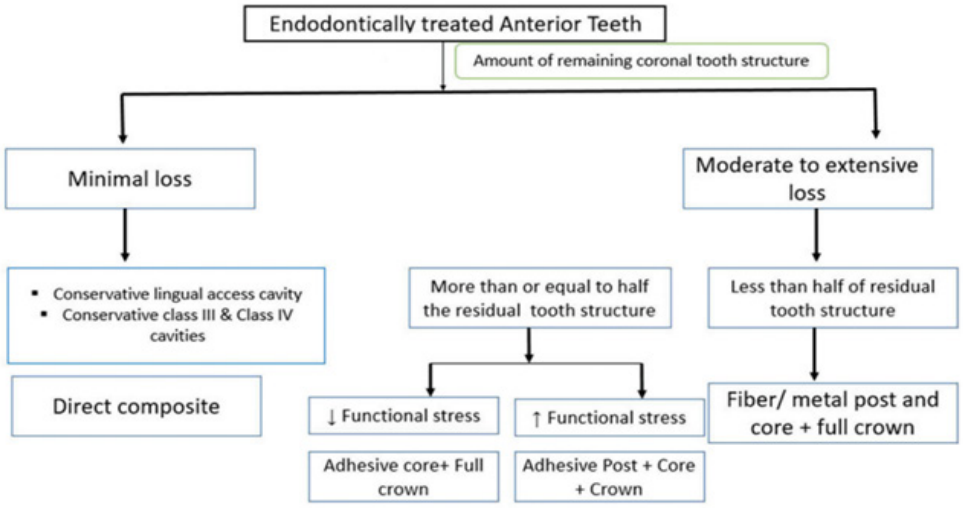


Figure 14: Clinical guidelines for restoring endodontically treated anterior teeth, adapted from "Decision making and restorative planning for adhesively restoring endodontically treated teeth: An update"

stress and reduce fracture risk. Ultimately, the choice of restoration depends on tooth structure, morphology, and function, with partial coverage and proper adhesive protocols offering durable, aesthetic outcomes for ETT.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

CONSENTS

Informed consent was obtained from the patient before preparing this case report.

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CASE REPORT

Double Incontinence as Adverse Effect During Brief Usage of Clonazepam

Al Hafiz Ibrahim[1,2], Ritzzaleena Rosli Mohd Rosli[3,4], Mohd Noor Norhayati[3], Shaiful Bahari Ismail[3,4]

[1] Rehabilitation Medicine Unit, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia
[2] Department of Orthopaedics, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia
[3] Department of Family Medicine, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia
[4] Klinik Rawatan Keluarga, Hospital Pakar Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia

* Corresponding author's email: ritzz.rosli@usm.my

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ABSTRACT

Clonazepam, a benzodiazepine used for treating seizures, anxiety disorders, and movement disorders, is known for its central nervous system depressant side effects, such as drowsiness and urinary incontinence. However, double incontinence is rarely reported. We present the case of a 41-year-old woman with multilevel degenerative disc disease and right gastrocnemius-soleus muscle spasticity secondary to an Achilles tendon rupture, who developed who experienced dual incontinence after brief clonazepam use. Within three days of commencing clonazepam, she experienced nausea, fatigue, drowsiness, loose stools, and urinary frequency, progressing to urinary and faecal incontinence. Investigations, including blood tests, urine analysis, and abdominal imaging, were unremarkable, ruling out differential diagnoses such as infections, spinal pathology, and metabolic disorders. The patient responded positively to the antidote and supportive medical care, with total symptom relief two days after cessation of the medication. We discussed the causes of double incontinence, potential drug-induced incontinence, and the possible mechanisms by which clonazepam could cause double incontinence, given the limited evidence on it. Clonazepam's sedative effects can lead to decreased muscle tone and coordination, potentially resulting in incontinence. Additionally, its impact on GABAergic pathways and anticholinergic effects could influence bladder and bowel function indirectly, but this

is just a theory, and actual evidence is difficult to find. underscores the need for clinicians to recognize double incontinence as a potential adverse effect of clonazepam, even with short-term use, and to consider dose adjustments or alternative therapies when indicated. Further research into the mechanisms of clonazepam-induced double incontinence is warranted given the limited existing evidence.

INTRODUCTION

Clonazepam is a benzodiazepine commonly prescribed for its anticonvulsant and anxiolytic properties. Emerging evidence supports its efficacy in managing myoclonus, particularly spinal segmental myoclonus(Edinoff et al., 2021). Primary adverse reactions include drowsiness, fatigue, sedation, and motor impairment(Lappasetal.,2023).Lesscommonly, it may cause blurred vision, psychomotor agitation, confusion, and irritability(Lappas et al., 2023). While some medications, especially antipsychotics (clozapine, olanzapine, risperidone, olanzapine and aripripazole) have been systematically reviewed as causing double incontinence, clonazepam has been underrecognized (Arasteh et al., 2021a). Studies in frail older adults indicate a 45% increased risk of urinary incontinence among benzodiazepine users, but evidence in middle-aged adults remains limited (Landi et al., 2002) The benzodiazepine class has frequently been associated with urinary incontinence; however, only occasional reports of urinary incontinence specifically implicating clonazepam (Landi et al., 2002; Tsakiris et al., 2008). Aside from an isolated report of urinary incontinence linked to clonazepam in 1979, only a single case report describing bowel incontinence related to lorazepam was published in 2018 (Güngören et al., 2018; Williams & Gillespie, 1979). (Williams & Gillespie, 1979) To date, no documented case has reported concurrent bowel and urinary incontinence associated with benzodiazepine use-particularly clonazepam.. Herein, we present what is, to our knowledge, the first reported case of simultaneous bowel and bladder incontinence following short-term clonazepam use, with complete resolution upon discontinuation of the medication.

CASE PRESENTATION

A 41-year-old female with underlying hypertension, diagnosed in 2016 and currently on Tab Losartan 50 mg once daily, was referred to the rehabilitation clinic for persistent right calf spasm. She also has multilevel degenerative disc disease, diagnosed in 2018, specifically affecting L4/L5 and L5/S1 with right exiting nerve root involvement at L4, diagnosed in 2019. Additionally, she sustained a left-sided Achilles tendon rupture of the right lower limb in 2017 after trauma from a falling fire extinguisher. The Achilles tendon rupture responded well to conservative treatment, but over a year, she developed progressively worsening right calf spasms. The gastrocnemius-soleus muscle is likely due to muscle compensation and altered biomechanics during the healing process. Despite multiple treatments with analgesics, including 300 mg of gabapentin twice daily and 200 mg of celecoxib as needed for the past six months, her symptoms persist.

Therefore, we initiated a nightly regimen of 0.5 mg clonazepam before bedtime during the clinic visit, aiming to alleviate the ongoing right calf spasms. A day after taking her first dose of clonazepam, she started to feel nausea, fatigue, loss of appetite, and drowsiness. She also had two episodes of loose stools and an increase in urinary frequency, urinating almost every one to two hours, with three episodes of nocturia Despite these symptoms, she continued to take her second dose of clonazepam on the following night. The next day, she had reduced consciousness and could not recall the number of urinary frequency, and the frequency of stool passed. Her caregiver had to put her in diapers due urinary and bowel incontinence. There were no dietary changes, sick contact, or history of

taking supplements that could have explained the incontinence. No history of trauma or neurological deficit prior to the symptoms.

Upon arrival at the emergency department, she was drowsy and mildly dehydrated. However, her vital signs were within the normal range. Her Glasgow Coma Scale (GCS) score was 12/15, with a score of 3 for eye-opening response (opens eyes to verbal command), 4 for verbal response (confused speech but able to communicate), and 5 for motor response (localized pain but reduced overall motor function). The abdominal examination revealed a soft and non-tender abdomen, with hyperactive bowel sounds. A full neurological examination was not performed as the patient was drowsy and fatigued. A per rectal examination showed an empty rectum and intact anal sphincter.

Blood samples were sent for a complete blood count, renal and liver function, random glucose, and electrolyte analysis. A urine sample was sent for culture, and an abdominal x-ray and ultrasound were done. All these investigation results were normal. At this point, an adverse drug reaction to clonazepam was suspected, and hence, clonazepam was stopped. A single 0.2 mg intravenous (IV) dose of flumazenil was administered, resulting in noticeable improvement in drowsiness within minutes. She was closely monitored with IV fluids, stool, and fluid charting. On the first day of admission, her loose stools reduced to two episodes, and by the following day, both bowel and urinary incontinence had completely resolved. With no recurrence of symptoms, she remained hemodynamically stable and was discharged in good condition.

During subsequent follow-up at the rehabilitation clinic, the patient then received an injection of botulinum toxin into her right calf muscles. Each gastrocnemius muscle head received 75 units of Dysport® intramuscular injection. Two weeks post-injection, the patient's reassessment revealed complete resolution of pain and spasm, as well as marked improvement in gait and function.

DISCUSSION

Clonazepam is a potent benzodiazepine tranquilizer with a half-life of of 20 hours and takes about 20 to 60 minutes for its onset of action (Ghit et al., 2021; Wu & King, 2024). This intermediate-to-long-acting GABA-A receptor agonist drug was widely endorsed for managing epilepsy and anxiety disorders (Dokkedal-Silva et al., 2019; Edinoff et al., 2022). Researchers also report its effective off-label use for sleep disorders, multi-infarct dementia, tinnitus, depression, withdrawal from other benzodiazepines, neuropathic pain management, myoclonus, and movement disorders (Edinoff et al., 2021; Ghit et al., 2021).

A comprehensive evaluation is essential to rule out all the potential causes of double incontinence. Faecal incontinence can arise from structural abnormalities such as sphincter injury or rectal prolapse, as well as neurological dysfunction including spinal cord injury and diabetic neuropathy (Knowles et al., 2022). It may also result from altered rectal sensitivity, inflammatory conditions, or disrupted colonic motility, reflecting its complex and multifactorial nature (Knowles et al., 2022). Urinary incontinence may result from urinary tract infections, overactive bladder, pelvic floor dysfunction, or neurological impairments affecting bladder control (Dobrek, 2023; Tsakiris et al., 2008).

For double incontinence, concurrent spinal pathology (e.g., cauda equina syndrome) or systemic conditions (e.g., autonomic neuropathy) should be considered. Drug-induced incontinence, though less common, is a critical differential, particularly with medications possessing anticholinergic, sedative, or muscle-relaxant properties, such as antipsychotics, opioids, or benzodiazepines (Dobrek, 2023; Knowles et al., 2022). In this case, the temporal association between

clonazepam initiation and symptom onset, along with the exclusion of structural, infectious, and metabolic causes, strongly supports drug-induced double incontinence as the primary diagnosis. This underscores the importance of medication review in patients presenting with unexplained incontinence.

Recent literature explains that drugs with sedatives and hypnotics mainly cause overflow or functional incontinence (Arasteh et al., 2021b). Contrarily, evidence on drug-induced bowel incontinence is sparse. Few cases reported double incontinence secondary to antipsychotic medications (Hergüner & Mukaddes, 2008; Incecik et al., 2015), but none related to the benzodiazepine group. The tranquilizer of the potent benzodiazepine takes about one to eight hours to reach its peak blood concentration, and its effect lasts around six to twelve hours (Edinoff et al., 2022). Toxicity by clonazepam alone is rarely lethal. Unlike in this case report, severe consequences due to CNS depressants often seen when taken in combination with ethanol, barbiturates, or opioids (Arasteh et al., 2021b; Hieger et al., 2024). Nevertheless, the patient in this case is not utilizing any of the aforementioned combination drugs.

The fundamental mechanism of how clonazepam can induce double (urinary and bowel) incontinence has been poorly documented in literature reviews. However, the potential pharmacokinetic explaination is that it crosses the blood-brain barrier, affecting brain regions involved in motor control and autonomic functions (mainly in the cortex and limbic region), which has an inhibitory neurotransmitter called gamma amino-butyric acid (GABA) (Ghit et al., 2021). The serotonergic effects increase GABA activity and depress the central nervous system (CNS) (Dokkedal-Silva et al., 2019; Lappas et al., 2023). This action leads to increased inhibition in the CNS, which can affect the neural pathways controlling bladder and bowel function.

Additionally, the sedative effects of clonazepam can lead to decreased muscle tone and coordination, potentially resulting in incontinence (Dokkedal-Silva et al., 2019). Inhibition of the limbic system may alter emotional responses to bladder and bowel sensations, contributing to incontinence (Edinoff et al., 2021, 2022). While clonazepam does not directly target α1 receptors, its impact on GABAergic pathways and anticholinergic effects could influence bladder and bowel function indirectly (Arasteh et al., 2021). The synergistic effects of these mechanisms potentially explain the cause of incontinence in this patient.

The fundamental principle in the management of clonazepam toxicity is supportive medical care tailored to the severity of the patient's condition. Flumazenil should not be used routinely in the management of benzodiazepine toxicity(Hieger et al., 2024). Recent evidence has shown that its usage is significantly related to serious adverse events such as seizures and arrhythmias (Hieger et al., 2024).

CONCLUSION

This report emphasizes the risk of clonazepam-induced both bowel and urinary incontinence, especially with short-term use. The patient's symptoms improved through non-pharmacological measures and targeted medications. This inaugural case highlights the urgent need for fundamental research into the mechanisms by which clonazepam may cause dual incontinence. This case underscores the necessity for clinicians to monitor patients closely for rare but significant adverse effects when prescribing clonazepam in their daily practice.

CONFLICT OF INTEREST

All of the authors have no conflict of interest.

CONSENT

Informed consent was obtained from the patient, and a copy of the written consent is submitted to the journal.

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SHORT COMMUNICATION

Integrating the Protection Motivation Theory Scale Among Older Adults: Insights for Fall Prevention Behaviour

Mei Fong Ong[1*], Kim Lam Soh[2], Rosalia Saimon[3], Ing Khieng Tiong[4], Hasni Idayu Saidi[5], Manfred Mortell[6]

[1] Department of Nursing, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
[2] Department of Nursing, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[3] Department of Community Medicine and Public Health, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Kuching, Sarawak, Malaysia
[4] Department of Geriatric Medicine, Institute of Sarawak Heart Centre/Sarawak General Hospital, Ministry of Health Malaysia, 94300 Kota Samarahan, Kuching, Sarawak, Malaysia
[5] Department of Biomedical Science, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[6] School of Nursing and Allied Health, University of the Bahamas, Nassau, N-7077, Bahamas.

*Corresponding author's email: mfong@unimas.my

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ABSTRACT

This commentary examines the application of the Protection Motivation Theory (PMT) scale to evaluate older adults' threat and coping appraisals, fear, and protective behaviours in reducing fall risks. The findings highlighted the impact of fear, threat and coping appraisals on older adults' intentions to adopt protection motivation to reduce fall risk. Mediating effects are found in coping appraisal for protective behaviour, fear for perceived cost, and threat appraisal for protection motivation. This study has also emphasised the implications of adopting the PMT scale among older adults in Sarawak, Malaysia.

INTRODUCTION

Falls have become a leading health concern with the growing proportion of older populations globally, often resulting in serious physical, psychological, and economic consequences (WHO, 2023). Older adults often shield their fall experiences due to misconceptions about the normalisation or stigmatisation of falls (Loganathan, Ng, & Low, 2016; Loganathan, Ng, Tan, & Low, 2015). Meanwhile, it has been reported that inadequate fall management is also linked to insufficient fall prevention policies or training opportunities for healthcare providers (Loganathan et al., 2015). Furthermore, several existing fall prevention programmes are implemented without a theoretical framework (Kiegaldie & Farlie, 2019). The Health Belief

Model (HBM) and Protection Motivation Theory (PMT) share similar concepts regarding protective behaviour, both involving cost-benefit analyses (Maddux & Rogers, 1983). However, the HBM does not fully explain the extent to which its components influence the preventive measures individuals adopt, unlike the PMT, which offers a more detailed account of motivation by considering both threat and coping appraisals (Floyd, Prentice-Dunn, & Rogers, 2000; Maddux & Rogers, 1983).

Therefore, an alternative PMT framework may enhance positive behavioural change among older adults and promote their independent living. (Kiegaldie & Farlie, 2019).

Findings

Figure 1 presents the results of the scale's reliability and validity, which indicate the path coefficients of the PMT components. A few of the PMT components act as mediators in the intention for protective behaviour among older individuals, such as coping appraisal, which was considered a mediator for protection motivation. Meanwhile, fear mediates each perceived cost and threat appraisal for protective behaviour. Therefore, coping appraisal and fear were identified as key mediators influencing protection motivation and intention to adopt fall-preventive behaviours.

Implications

The scale for this PMT could be further enhanced to suit the older communities in a respective country, especially if the study's participants were from low-education backgrounds, which may affect their options or perceptions of the PMT's components. Conversely, several implications follow the assessment of older adults' intentions to adopt fall protective behaviour:

- Threat appraisal (including perceived severity, vulnerability and rewards): Interventions aimed at fostering older adults' independent living by educating and improving their fall risk awareness (Institute for Public Health, National Institutes of Health, & Ministry of Health Malaysia, 2019). By considering the contributing factors to the stigmatisation of falls, interventions to reduce non-preventive behaviours among older adults may promote their greater engagement in protective behaviours.
- Fear: Assessing older individuals' fear of

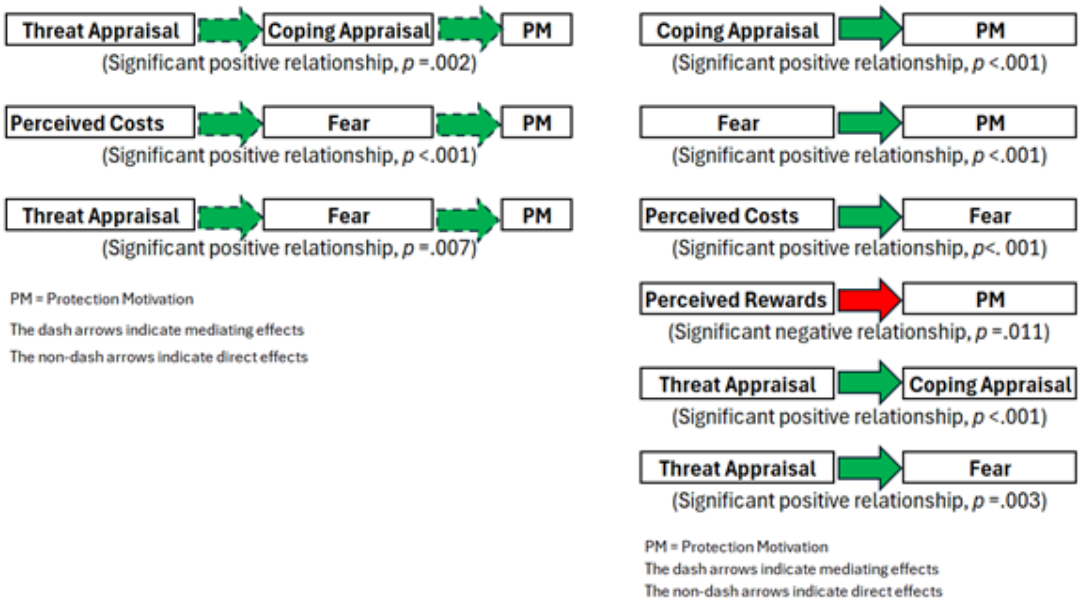

Figure 1: Summary findings from the structural model assessment of the PMT components

falling in their intention for fall protective behaviour (Montero-Odasso et al., 2022; Popova, 2011).

- Coping appraisal (including self-efficacy, response efficacy and perceived costs): Efforts from policymakers to improve the communications between healthcare providers and older adults on fall risk reductions and prevention strategies, improve health promotion programmes and information dissemination among rural communities and alternative preventive measures for falls. In addition, efforts from policymakers should include culturally sensitive communication strategies tailored to older adults' socioeconomic realities (Montero-Odasso et al., 2022).

CONCLUSION

Applying the PMT scale among older adults in Malaysia enabled assessment of the extent to which older adults intend to engage in fall-prevention behaviours. It could also assist healthcare providers in identifying the most prominent factors among older adults that encourage the adoption of preventive behaviours to minimise their risk for falls. Additionally, further refinement and testing of the scale could also confirm these outcomes.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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