SLEEP APNOEA FROM A DENTIST'S POINT OF VIEW

Marcela Šestáková[1], Alexandra Janíčková[2], Eleonóra Ivančová[3], Mária Eötvösová[4], Viliam Donič[5], Erik Dorko[6], Kvetoslava Rimárová[6]

[1]First Dental Clinic, Faculty of Medicine, Pavol Jozef Šafárik University and Louis Pasteur University Hospital in Košice, Košice, Slovak Republic
[2]Private Dental Practice, Prešov, Slovak Republic
[3]Department of Dentistry and Maxillofacial Surgery, Faculty of Medicine, Pavol Jozef Šafárik University and Louis Pasteur University Hospital in Košice, Košice, Slovak Republic
[4]Department of Dentistry and Maxillofacial Surgery Academia Košice, n.o., Košice, Slovak Republic
[5]Department of Medical Physiology, Faculty of Medicine, Pavol Jozef Šafárik University in Košice, Košice, Slovak Republic
[6]Department of Public Health and Hygiene, Faculty of Medicine, Pavol Jozef Šafárik University in Košice, Košice, Slovak Republic

SUMMARY

Objectives: The aim of this study was to confirm the relevance of knowledge a dentist has regarding obstructive sleep apnoea (OSA), considering the fact that based on specific risk factors a dentist may be the first clinician to identify patients who are at risk of being affected by this serious condition.

Methods: The cohort consisted of 53 subjects who underwent a routine dental examination. Anthropometric data and data on tongue size (Mallampati classification), tonsil size (Friedman classification), daytime sleepiness (Epworth Sleepiness Scale) and systemic risk factors were recorded in a record sheet. On the basis of the monitored parameters, selected subjects underwent polysomnography in order to objectivise the parameters observed.

Results: Polysomnography confirmed a 96% success rate in our identifying subjects as being at high risk of developing OSA. This indicates that the parameters monitored during a routine dental examination were properly selected to identify patients with this condition in advance.

Conclusion: The relevance of information dentists have about the early identification of patients with OSA may be crucial in the management of further therapy to be provided to these patients.

Key words: obstructive sleep apnoea, risk factors, dental examination

Address for correspondence: E. Dorko, Department of Public Health and Hygiene, Faculty of Medicine, Pavol Jozef Šafárik University in Košice, Šrobárova 2, 041 80 Košice, Slovak Republic. E-mail: erik.dorko@upjs.sk

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INTRODUCTION

The quality of sleep affects daily life, and sleep disturbances can have a negative impact on a person's overall health status. One of the most commonly occurring sleep disorders is sleep apnoea. Apnoea is defined as breathing dysfunction, respiratory arrest. Effort-induced apnoea is referred to as voluntary apnoea or holding one's breath. When pathological breathing arrest occurs 5 to 30 times per hour during sleep, we speak of sleep apnoea. A distinction is made between central sleep apnoea, which is less common and mainly caused by ischaemic disorders of the respiratory centre, and the more common obstructive sleep apnoea (1).

Obstructive sleep apnoea (OSA) is a condition characterised by temporary cessation of breathing caused by repeated upper airway (upper respiratory tract) collapse during sleep. OSA is a common disorder associated with abnormalities in pharyngeal anatomy and physiology in which the airway muscles that normally relax during sleep fail to provide sufficient dilatory force during inspiratory activity. This imbalance causes partial or complete collapse of the upper respiratory tract, preventing sufficient airflow to the lungs. Pauses in breathing lead to a drop in blood oxygen and induce neurological excitation, resulting in sleep interruption and fragmentation. The cycle of airway collapse and opening can be repeated multiple times per night (2). It develops predominantly in the REM phase of sleep, when muscle atonia occurs (3). The major risk factors in the development of OSA include age, obesity, male sex, and female menopause (4).

In addition to the risk factors mentioned above, the clinical presentation of the oral cavity is also of importance. When performing regular examinations, dentists can predict the level of risk of developing OSA based on anthropometric values and clinical findings. One of the first signs of sleep apnoea to be found in a patient's oral cavity is the presence of pathological attrition of the hard dental tissues – the non-physiological wear of the incisal edges and occlusal surfaces of the teeth caused by bruxism. Changes in the periodontium in terms of gingival recession and group abfraction lesions of the teeth in the cervical region, especially in the premolar region, and the consequent increased sensitivity of the teeth are also clinical warning signs telling the dentist that the patient may be developing OSA. As part of the general physical examination of the head and neck, factors affecting the size of the upper airway lumen should be evaluated. In addition to identifying patients, dentists may also become significantly involved in their treatment.

The objective of our study was to point out the relevance of knowledge dentists possess about OSA syndrome. This is the knowledge that allows them to recognise a patient with obstructive sleep apnoea based on their medical history and a clinical examination during a routine preventive dental exam. In our study, we focused on:

- elaborating a record sheet for dentists to diagnose OSA;
- assessing risk factors that increase the likelihood of upper airway obstruction;
- evaluating the general clinical condition and clinical picture of the oral cavity of a patient with obstructive sleep apnoea established in their medical history.

MATERIALS AND METHODS

Between December 2018 and March 2020, we conducted an observational case-control study at two dental clinics of the Faculty of Medicine and Louis Pasteur University Hospital in Košice.

Cohort Characteristics

The inclusion criteria used were the clinical features and risk factors for sleep apnoea determined in the examined patient, on the basis of which we assumed the occurrence of sleep apnoea. Patients in whom we failed to observe the clinical features and risk factors suggestive of the presence of sleep apnoea were excluded from our study. The cohort comprised 53 patients of both sexes.

Anthropometric Data and Assessment of Risk Factors for OSA

The risk factors evaluated included sex, age, BMI, neck circumference, tongue size assessed according to the Mallampati classification, and tonsil size assessed according to the Friedman classification grading scales. A feeling of tiredness and fatigue was evaluated using the Epworth Sleepiness Scale (ESS). We recorded data in a record sheet we had prepared in advance (Supplementary Material).

Patients underwent a routine preventive dental exam, including an assessment of their general medical history, and an extraoral and intraoral examination. Data on sex, age, weight and height of the patient were obtained from their medical records and medical history.

Body mass index (BMI) values were calculated using a mathematical formula – weight in kilograms divided by height in metres squared (kg/m^2). Normal BMI values range between 18.5 and 24.9 (5).

Neck circumference was assessed by measuring the neck at the upper edge of the cricothyroid membrane using a sewing tape measure in centimetres. Measured neck circumference values above 37 cm in men and 33 cm in women represent a risk of developing sleep apnoea (6).

The Mallampati classification evaluates tongue size and the effect thereof on sleep apnoea (7). Tongues are scored and classified into 4 classes according to size: Class I is present when the soft palate, uvula and pillars are visible; Class II when the soft palate and the uvula are visible; Class III when only the soft palate and base of the uvula are visible; and Class IV when only the hard palate is visible.

We evaluated the tongue size after asking the patient to protrude their tongue in the midline. We matched the data obtained by visual inspection to the Mallampati classification pictures in the record sheet. After subsequent retraction of the tongue to the floor of the mouth, we lightly pressed the tongue caudally using a dental mirror and assessed the size of the tonsils by visual inspection. We recorded the tonsil size score in the record sheet according to the Friedman classification picture template (7). The Friedman classification staging system defines tonsillar tissue size using score values ranging from 0 to 4. With a score of 0 the tonsils are not visible due to the absence of tonsillar tissue; a score of 1 defines tonsils hidden within the tonsillar fossa, with tonsillar tissue within the pillars; and a score of 2 describes tonsillar tissue as slightly protruding from the tonsillar fossa, extended to the pillars. A score of 3 is characterised by the presence of tonsillar tissue near the uvula, extended past the pillars but not extended to the midline; and a score of 4 the tonsils are visible near the uvula, with tonsillar tissue extended to the midline.

After completing the physical examination and recording the data, communication with the patient allowed us to obtain information on their fatigue during the day, which was then assessed using the Epworth Sleepiness Scale (8). The prevalence of excessive daytime sleepiness in patients with OSA has been attributed to factors such as intermittent nocturnal hypoxemia and sleep fragmentation with altered sleep architecture.

Other risk factors that we monitored included smoking, the presence of cardiovascular diseases, specifically of hypertension, tenderness or pain in the temporomandibular joint, and pathological attrition of hard dental tissues. We obtained these data by assessing the patient's medical history and carrying out an objective clinical examination, noting the positivity but not the severity of the risk factor.

If we concluded that a patient was at risk, we indicated that a remote radiograph be taken to assess the size of the upper airway lumen, and we referred the patient to the sleep laboratory for nocturnal polysomnography.

Analysis of Data

We processed the obtained data using the Excel spreadsheet software and evaluated the frequency of occurrence of the parameters observed and the percentages of the data obtained. Based on the characteristics of the collected data, hypotheses were focused on differences between the male and female group.

Hypothesis H1: There is a statistically significant difference in age of respondents with potential OSA between men and women.

Hypothesis H2: There is a statistically significant difference in BMI index of respondents with potential OSA between men and women.

Hypothesis H3: There is a statistically significant difference in the Mallampati classification between male and female group.

Hypothesis H4: There is a statistically significant difference in the Friedman classification between male and female group.

Hypothesis H5: There is a statistically significant difference in the Epworth Sleepiness Scale based on gender.

For statistical analysis, given the established hypotheses and the nature of the data, the Mann-Whitney U test for 2 independent samples and the Chi-square test were used. Each of these tests was used for individual hypotheses in accordance with the nature of the specific data appearing in the given hypothesis. The statistical analysis was performed in the SPSS 22 program.

RESULTS

The age composition of the cohort in relation to sex and the entire group is presented in Table 1. Males comprised a group of 27 (50.94%) patients, and there were 26 (49.06%) females in our cohort. The age of the patients included in the cohort ranged from 22 years (female) to 73 years (female). The mean age of those examined was 49.27 years (females) and 51.00 years (males), respectively, and the average age of patients was 50.15±12.96; 22 (41.51%) of the evaluated patients who showed signs of sleep apnoea were in the age range of 50 to 59 years. This was true in both the male and female group. To analyse Hypothesis H1, the non-parametric Mann-Whitney U test for 2 independent samples was used, after taking into account the nature of the variables. Based on the results (p=0.776), a conclusion was reached that there is no statistically significant difference in the age of respondents between men and women. Hypothesis H1 was not confirmed.

When evaluating BMI, we found that up to 38 (71.69%) of our patients were in the risk range for sleep apnoea, namely due to being overweight, i.e., presenting values greater than 25.0 kg/m^2. Normal BMI values were present in only 4 males and 11 females, representing less than one-third (28.31%) of the evaluated patients. A detailed overview of the cohort is presented in Table 2. Being overweight is also associated with the assumption of fatty tissue accumulation in the neck region. In our cohort, 25 males and 24 females, thus a total of 92.45% of our subjects, exceeded the risk value set out for the neck circumference. For the analysis of Hypothesis H2, after taking into consideration the nature of the variables, the non-parametric Chi-square test was used. Based on the results (p=0.026), there is a statistically significant difference in the BMI index between men and women. Male group has a statistically significantly higher BMI index than female group. Hypothesis H2 was confirmed.

In patients at risk, a tongue size of Class III and IV according to the Mallampati classification predominated and was observed in 30 (56.60%) patients. In 19 (35.85%) cases, patients were assigned to Class III and in 11 (20.75%) patients, tongue size Class IV was determined. The Class I group consisted of 13 (24.53%) subjects, and in 10 (18.87%) patients, we assessed the tongue size as belonging to Class II. The detailed distribution of the subjects is shown in Table 3. To analyse the Hypothesis H3, the non-parametric Mann-Whitney U test for 2 independent samples was used, after taking into account the nature of the variables. Hypothesis H3 was not confirmed, there is no statistically significant difference (p=0.327).

The Friedman classification defines the size of palatine tonsillar tissue. The majority of the 45 (84.91%) patients evaluated were categorised into the lower score classes, 0 to 2, which is indicative of a good uvulopalatopharyngoplasty (UPPP) prognosis. In these patients, mild apnoea can be assumed. Another 6 (11.32%) patients had a score of 3, and 2 (3.77%) patients had a score of 4, i.e., the tonsils were visible in the area near the uvula with tonsillar tissue extended to the midline. Based on such a clinical presentation, severe apnoea and a worse UPPP surgery prognosis can be assumed in these patients. Comprehensive findings according to the Friedman classification are shown in Table 4. To analyse the Hypothesis H4, the non-parametric Mann-Whitney U test for 2 independent samples was used taking into account the nature of the variables. According to the results, Hypothesis H4 was not confirmed, there is no statistically significant difference (p=0.137).

Paradoxically, sleepiness during the day as a consequence of poor-quality sleep was not experienced by many OSA patients, as evidenced by the values we recorded in our cohort. A total of 37 (69.82%) subjects reported that they did not experience significant daytime sleepiness. Mild sleepiness was experienced by 11 (20.75%) patients, moderate sleepiness by 4 (7.55%) subjects from the entire cohort, and severe sleepiness was reported by only

Table 1. *Age distribution of the cohort*

Age	Males (n)	Females (n)	Cohort (n)
20–29	0	4	4
30–39	3	4	7
40–49	7	1	8
50–59	12	9	22
60–69	4	5	9
70–79	0	3	3
Total	27	26	53

Table 2. *BMI values*

	BMI	n (%)	p-value
Males	Up to 24.9	4 (7.52)	0.026
	Above 25.0	23 (43.42)	
Females	Up to 24.9	11 (20.75)	
	Above 25.0	15 (28.31)	
Cohort	Up to 24.9	15 (28.31)	
	Above 25.0	38 (71.69)	

Table 3. *Mallampati classification values*

	Mallampati	n (%)
Males	I	6 (11.31)
	II	4 (7.55)
	III	10 (18.87)
	IV	7 (13.21)
Females	I	7 (13.21)
	II	6 (11.32)
	III	9 (16.98)
	IV	4 (7.55)
Cohort	I	13 (24.53)
	II	10 (18.87)
	III	19 (35.85)
	IV	11 (20.75)

Table 4. Friedman classification results

	Friedman	n (%)
Males	0	8 (15.08)
	1	4 (7.55)
	2	10 (18.87)
	3	4 (7.55)
	4	1 (1.89)
Females	0	8 (15.09)
	1	13 (24.54)
	2	2 (3.77)
	3	2 (3.77)
	4	1 (1.89)
Cohort	0	16 (30.19)
	1	17 (32.08)
	2	12 (22.64)
	3	6 (11.32)
	4	2 (3.77)

Table 5. Epworth Sleepiness Scale evaluation

	ESS	n (%)
Males	0–10	17 (32.08)
	11–14	5 (9.43)
	15–17	4 (7.55)
	18–24	1 (1.88)
Females	0–10	20 (37.74)
	11–14	6 (11.32)
	15–17	0 (0.00)
	18–24	0 (0.00)
Cohort	0–10	37 (69.82)
	11–14	11 (20.75)
	15–17	4 (7.55)
	18–24	1 (1.88)

1 (1.88%) patient. A feeling of sleepiness during the day of varying degrees was reported by males with great preponderance. The data are summarised in Table 5. The non-parametric Mann-Whitney U test for 2 independent samples was used to analyse Hypothesis H5. According to the results, Hypothesis H5 was not confirmed, there is no statistically significant difference ($p=0.158$).

Our attention was also focused on the presence or absence of risk factors and the combinations thereof. We considered snoring, hypertension, smoking, and possible temporomandibular joint (TMJ) pain as risk factors. The findings are presented in Table 6.

A polysomnographic examination is necessary to confirm a diagnosis of OSA. Only 14 (26.42%) patients in our cohort agreed to undergo a sleep study in a sleep laboratory, and our presumptive diagnosis of OSA was confirmed in 13 (92.86%) of them on the basis of polysomnography. In all these patients, the clinical picture included an elevated BMI and a sex-specific neck circumference risk score combined with a Mallampati classification tongue size of Class III or IV.

DISCUSSION

Senaranta et al. wrote a review of 22 available heterogeneous studies determining the prevalence of obstructive sleep apnoea among the general population. The prevalence of OSA as reported in the said reviewed studies ranged from 9% to 38% (9). Considering the fact that our cohort included only those patients in whom we had already hypothesised OSA, it is not possible to assess the prevalence of this condition within the cohort. However, the diagnosis of OSA was confirmed by polysomnography in 13 of the 14 subjects we selected, thus representing a 93% success rate of our judgment. These values emphasise the success in identifying patients with OSA by dentists based on the parameters we established.

With aging, the frequency of occurrence of OSA increases. Due to preferential deposition of fat in the soft tissues around the pharynx and increased upper airway surface tension, the aging population becomes more susceptible to upper airway closures (10). Men are 2- to 3-times more likely to develop OSA than women. Male apnoeic pauses last longer and are accompanied by a more pronounced decrease in oxygen saturation, even at

Table 6. Overview of risk factors

Risk factor	Snoring n (%)	Hypertension n (%)	Smoking n (%)	Temporomandibular joint pain n (%)
Males	19 (35.85)	16 (30.19)	5 (9.44)	14 (26.42)
Females	16 (30.19)	11 (20.75)	2 (3.77)	13 (24.52)
Cohort	35 (66.04)	27 (50.94)	7 (13.21)	27 (50.94)

Risk factor	No RF n (%)	1 RF n (%)	Combination of 2 RF n (%)	Combination of 3 RF n (%)	Combination of 4 RF n (%)
Males	1 (1.88)	8 (15.09)	9 (16.98)	8 (15.09)	1 (1.88)
Females	4 (7.54)	8 (15.09)	8 (15.09)	6 (11.32)	0 (0.00)
Cohort	5 (9.43)	16 (30.19)	17 (32.08)	14 (26.42)	1 (1.88)

lower BMI values. The male predisposition to OSA is anatomically based on increased fat deposition around the pharynx. Fat deposition in the abdominal region contributes to a reduction in lung volume in males, increasing the susceptibility to upper airway closures (10). In females, oestrogen and progesterone have a protective effect on upper airway patency. However, menopause, pregnancy and polycystic ovary syndrome increase the risk of OSA. Apnoeic pauses observed after menopause are longer than pauses observed before menopause, and thus there is a worsening of OSA severity during the non-REM phase of sleep, in contrast to the REM phase before menopause (10). Menopause may also be related to redistribution of body fat to the abdominal region and loss of muscle mass (11).

According to the following studies, the prevalence of OSA is 1.7-times higher in men than in women (12), and, at the same time, higher in patients older than 40 years of age (13). As reported by McMillan and Morrell, elderly patients show an increased susceptibility to upper airway collapse during sleep because upper respiratory muscle tension decreases with increasing age (14). Similar results are reported in our study. A larger group of our study patients consisted of males, numbering 20 (37.73%), in the age range of 41 to 59 years. In relation to females in this age group, who numbered 10 (18.87%), this is a 2:1 ratio in favour of males.

The high prevalence of OSA in obese people is associated with intra-abdominal fat accumulation. Enlargement and expansion of adipose tissue in the neck area and around the pharynx predisposes them to airway obstruction. An increase in BMI by 1 kg/m^2 quadruples the prevalence of OSA in middle-aged individuals (15).

Gray et al. reported that 25% of OSA patients have BMI values greater than 25 kg/m^2 and 54% of OSA patients have values greater than 30 kg/m^2, which means that up to 79% of OSA patients are overweight (16). BMI is known to affect multiple body systems. The prevalence of OSA is increased in obese patients (17). Excess body weight also leads to structural and functional changes in the upper respiratory tract (16). Up to 71.69% of our study patients had BMI values indicating overweight.

The following studies provide results regarding the Mallampati classification scores and OSA. Shah et al. claim that 69.3% of patients have a risk score for tongue size according to the Mallampati classification (18). Our study has confirmed these results, as 69.2% of our patients diagnosed with OSA in the sleep laboratory were classified into Class III or IV of the Mallampati classification. In four patients with a tongue size indicative of a risk, we also observed the presence of a clinical picture of impressiones dentales linguae.

Although the study by Baradaranfar et al. (19) showed that UPPP surgery in patients with high Mallampati classification scores is beneficial and reduces the incidence of apnoeic pauses in 64% of patients, this was not confirmed in the case of our patient. The risk factors for sleep apnoea observed in our patient were male sex, age of 43 years, BMI of 24.50 as well as a Mallampati classification score of IV and a Friedman classification score of 4. Attrition of hard dental tissues was caused by confirmed bruxism and a proven maxillo-orthopaedic anomaly. The said patient was examined during a follow-up polysomnography after undergoing the indicated tonsillectomy and UPPP, with this surgical procedure proving to be ineffective in his case. The reason for this could have been the high Friedman classification score, which reduces the efficacy of surgical treatment. Only an individually fabricated occlusive dental splint was effective. This confirms the results of the study by Stanley et al., who observed that using an occlusive dental splint was an effective treatment option in patients with persistent obstructive sleep apnoea after a failed UPPP (20).

OSA can also be diagnosed in patients with low Friedman classification scores, as indicated by 92.35% of our patients with OSA confirmed by nocturnal polysomnography. By conducting this study, we confirmed the outcome data of Berg et al. study, in which 98.10% of OSA patients had a palatine tonsil size with a low Friedman classification score (21).

According to a study conducted by Omobomi et al., 74.4% of patients with OSA experience daytime sleepiness (22). Contrary to our assumptions, our study predominantly included patients who did not experience daytime fatigue despite being subsequently diagnosed with OSA. Only 30.7% of the patients with confirmed OSA reported feeling sleepy. By their percentage, it can be argued that the assessment of daytime sleepiness on the basis of the ESS is highly subjective, and therefore the ESS results cannot be considered reliable in establishing the diagnosis of sleep apnoea. A more pronounced feeling of sleepiness was reported by male patients.

The best-studied comorbidity in obstructive sleep apnoea is systemic hypertension. There is a large body of epidemiological data and evidence on the bidirectional relationship between OSA and hypertension. The prevalence of obstructive sleep apnoea in patients with hypertension is approximately 30 to 50%, whereas hypertension is present in 50% of patients with OSA (23). In our study, up to 84.6% of the patients diagnosed with OSA reported a history of hypertension.

However, there are certain limitations to our patient cohort and the conducted study.

Firstly, all our patients were Slovak and Caucasian. Caution should thus be exercised when applying these results to other ethnic and racial groups.

Secondly, not all of our patients participated in the polysomnographic examination. Several of them did not consent to sleep testing in a sleep laboratory. The reason for their refusal of this diagnostic examination was the fact that, despite having received an explanation on the severity of the diagnosis, our patients still consider sleep apnoea to be a non-serious and non-life-threatening syndrome, and they underestimate the facts about OSA. Another reason for the smaller number of patients who participated in the nocturnal sleep study was the time consuming nature of the said examination, i.e., the long waiting times for the examination itself, and the long waiting times for the examination results, which meant that we would not have been able to have some of the sleep laboratory examinations carried out within the time period allotted to this study.

Thirdly, because of the limited number of X-rayed patients, we do not report on the relationship between upper airway lumen size and OSA in the results. It would have been interesting to investigate this phenomenon; however, these possibilities were not feasible in the case of this study, but they could be considered in future research.

Despite the mentioned limitations, our study demonstrates the importance of the knowledge a dentist possesses about the clinical picture and risk factors of obstructive sleep apnoea, which may make dentists the first clinicians to point out to the possibility of determining this diagnosis in examined patients.

CONCLUSION

The ultimate objective of our study was to point out the risk factors for obstructive sleep apnoea, the knowledge which can be used by a dentist to predict the occurrence of OSA in examined patients. Some risk factors are also of interest to dentists. Our study included the clinical picture of the oral cavity observable in patients with OSA, both as a cause and a consequence of the condition.

The diagnostic possibilities from the dentist's point of view and the dentist's cooperation in establishing the resulting diagnosis by polysomnography were demonstrated by the results of this study. Up to 96% of our examined patients who were referred to the sleep laboratory for polysomnography by a dental clinic were diagnosed with OSA – the diagnosis we had presumed.

The successful selection of OSA patients was guided by the appropriate and correct selection of the parameters evaluated in the elaborated diagnostic record sheet, namely, sex, age, neck circumference, BMI values, tongue size according to the Mallampati classification, palatine tonsil size according to the Friedman classification, and the feeling of fatigue as assessed by the Epworth Sleepiness Scale. The combination of these parameters, along with the condition of the hard tissues of the teeth and periodontium, leads dentists to taking a remote X-ray of the skull, interpreting it and referring patients to a sleep laboratory for examination.

The results of our study highlight the ability of dentists to identify patients with OSA. In our paper, we have demonstrated that the clinical picture of the oral cavity and therefore the information obtained from a comprehensive examination thereof, together with the overall clinical picture, helps diagnose patients with obstructive sleep apnoea.

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Conflicts of Interest

None declared

Electronic Supplementary Materials

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