Correlation between Snoring, Apnea and Obstruction of Upper Respiratory Tract
(Population Study in Jakarta and its vicinity)

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Abstract

Obstruction of Upper Respiratory Tract (OURT) may developed a various symptoms on certain children, which during the development period might cause dentocraniofacial deviation, and furthermore low self esteem. The characteristic of patients with OURT are mouth breathing (MB), sleep with snoring loudly, and on certain children may occur Obstruction Sleep Apnea (OSA).

The correlation between snoring and OSA with OURT. Across sectional design study was done with 285 OURT subjects. All subjects were divided into two groups, 9-12 years, and 12-15 years group. Data obtained from cephalometric analyses and questionnaire, and analysed with chi quadrate analyses.

The results showed Fujioka ratio on OURT subjects experience apnea and snoring, both for two different age categories (age 9-11 years and 12-15 years) were approximately the same with subjects no experience ($p>0.05$). McNamara modification line on both age group showed no difference ($p>0.05$) between experience and no experience apnea during sleep, but there was a significant difference ($p<0.05$) on subjects experience snoring during sleep.

There was no relation between Fujioka ratio and McNamara modification line with the apnea suffered by OURT subjects in the two age groups. There was no relation between snoring with Fujioka ratio in the two age groups. Meanwhile, there was a relation between McNamara modification line with snoring experienced by OURT subjects in age group 12-15 years. McNamara modification line on OURT subjects showed significant difference between snoring and no snoring during sleep, both in age category of 9-11 years and 12-15 years. There was a relation between McNamara modification line with snoring experienced by OURT subjects in age group 12-15 years.

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Introduction

Normally, if a person was breathing, air flow to the nose, nasopharynx, oropharynx, and then to the lower respiratory tract without obstruction. Chronic or acute infection of upper respiratory tract will cause obstruction in this area. Obstruction of the upper respiratory tract (OURT) suffered by the patients during their development period has played an important part in the pathophysiology of the occurrence of mouth breathing (MB). Someone has a problem with nose breathing, will choose the upright position during their sleep. They raise the position of the heads, so their heads will be lifted up. In the long run off growth and development, it may cause a deviation in the morphology of dentocraniofacial (DCF).

Facial appearance of dentocraniofacial deviation of OURT patient is adenoid face with lip incompetence. The conclusion of previous study was effect on dentocranialfacial structures are long face height, narrow face, increase mandibular plane angle and retrognathic mandible. Intraoral defects are upper proclined incisors, posterior crossbite and anterior open bite.[1]

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Patients of OURT with adenoid face have less interesting character and difficult personality. Tanugraha *et al* proved that malocclusion patients with adenoid face have the lowest self esteem.[2] Clinical observation showed patients suffered adenoid face have low self esteem. According to Sahin *et al* there was no significant association was determined between habitual snoring and poor school performance.[3]

The characteristic of patients with OURT are mouth breathing (MB), sleep with snoring loudly, and on certain children may occur Obstruction Sleep Apnea (OSA).The prevalence of Sleep Apnea Syndrome (SAS) was 5% in the active population.[4]

Sleep apnea is a complete obstruction in the upper airway will cause total cessation of airflow. It characterized by an interuption of airflow (breathing) for at least 10 second or more. Common symptoms of sleep apnea is loud snoring. It can be serious because the breath was repeatedly stopped and often wake up people with sleep apnea because of difficulty breathing.

Obstruction Sleep Apnea Syndromes (OSAS) are symptoms that accompany OSA, but rarely happen, namely hypertension, enuresis, night headache, and personality disorders in the afternoon. Further impact can occur is cardiopulmonary symptoms. Wang concluded it is very important to early recognize and diagnose OSAS due to there are correlation between OSAS and various cardiovascular diseases.[5]

Quite a lot effects of MB habit, such as the general of growth and development, DCF morphologic deviation, symptoms of apnea and snoring while sleeping. Furthermore it can be affect the intelligence, personality deviations, low self-esteem, and low quality of life. According to Jefferson, the characteristic of patients with OURT is snoring loudly.[6] Conclusion of Sahin *et al* study were Children with HS were more likely to have sleep-related daytime and night time symptoms. No significant association was determined between HS and poor school performance.[3]

OSA in children have typical symptom i.e. noisy breathing at night, discharge of secretions from the nose during the day but rarely experience drowsiness during the day compared to adults. Obstructive hipopnea occur more frequently than in apnea. In severe cases, can cause reversible mentally retarded and heart failure. These symptoms are called Obstruction Sleep Apnea Syndrome (OSAS). Further more can occur psychosocial defect.

Linder-Aronson in 1970 mentioned that symptoms caused by the enlargement of adenoid occur more frequently to children with relatively small nasopharynx.[7,8] On certain children, it can develop into obstructive apnea which during the development period might cause craniofacial anomaly or neuromuscular or the abnormalities in the central nerve system.[8] It has not been decided yet whether the small size of lumen nasopharynx has anything to do with snoring and apnea. How about Indonesian population of Fujioka Ratio and McNamara modification line who suffered snoring while sleep and apnea?

The purpose of this study was to compare Fujioka ratio and McNamara modification line between snoring and no snoring while sleep patient, between apnea and no apnea experience while sleep patients of those who suffered OURT, as part of a data collection program for the prevention and treatment and improve quality of life of OURT patient. The hypothesis was Fujioka ratio and McNamara modificaton line between snoring and no snoring while sleep patient, between apnea and no apnea experience while sleep patients of those who suffered OURT might be different. Other hypothesis are there are corelation between Fujioka ratio and McNamara modification line with snoring and apnea experience while sleep of those who suffered OURT.

Materials and methods

A cross-sectional study design with 120 OURT subjects (male and females aged 9 to 11 years) and 165 OURT subjects (male and females aged 12-15 years). Research had been conducted to identify the capacity of upper respiratory tract of OURT patients by measuring the Fujioka ratio and McNamara modification line. This research was a part of a case control study as a main research.

Inclusion criteria for the subject were patient was chosen as samples was living in Jakarta and it's vicinity (Jakarta, Bogor, Depok, Tangerang, Bekasi) with race Deutro-Malay; age 9-15 years; male and female; well general health. Subject suffered OURT.

Selection of the subjects, first a cross section was conducted to identify OURT patients

that developed the bad habit of MB. Medical records of OURT patients were studied to find new cases that had been diagnosed by the ENT specialists with hypertrophic tonsiloadenoid and or permanent nasal obstruction.

A questionnaire were needed for OURT detection. Test item analysis was conducted, as well as the reliability and validity of test in order to gauge this questionnaire rated good and could be used. Test the reliability of using internal consistency test with Cronbach coefficient alpha and the correlation test. In conclusion, the questionnaire was eligible for specifity and sensitivity revealed a risk factor in OURT and mouth breathing (MB) that affect the occurrence of DCF dicrepancies. Questionnaires were then distributed to identify patients with history of rhinitis, pharyngitis, snoring and apnea while sleeping in order to detect whether they were exposed to OURT or not. OURT subject with apnea experience as the case subject and without apnea as the control subject. Simirally, for snoring variable, OURT subject with snoring experience as the case subject and without snoring as the control subject.[1]

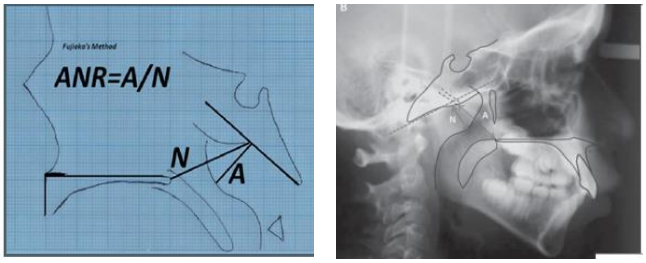
Exclusion criterias for the subject were had bad oral habit except mouth breathing and mouth breathing followed tongue thrust (not truly tongue thrust). Subject with tonsillectomy and adenoidectomy history, was being suffer cough and common cold or influenza; ever suffered serious disease that interrupting growth and development, asthma; and ever got orthodontic treatment. Subject had decay or missing or abnormality teeth and jaw may inhibit dentocranofacial growth and development.

Research subject determined by the formula of the main research, case control study based on the proportion of events obtained from the preliminary stages.[9] Based on the results of the preliminary study, risk factors male gender, the proportion of the effect on the control of the DCF without deviation: P2=0.4, the number of subjects was 134. Thus, the case N=134 and N= 134 in the control group. The total number of subjects was 268.

Population of subject were visitors of Cipto Mangunkusumo Hospital, The Ear Nose & Throat Department Faculty of Medicine Universitas Indonesia, Orthodontic and Pediatric Dentistry Department Dental Hospital of the Faculty of Dentistry, Universitas Indonesia.

Nasopharyngeal space could be measured by Fujioka ratio, looking at the size of adenoid. Nasopharyngeal space could also be measured by McNamara Line of the space behind soft palate.[10]

Fujioka Ratio would be measured on lateral cephalometric radiography. Photography exposure using 100 kv and 50 mA, with distance from tube to cassette 180 cm. The photograph result would be 65% medial field by this technique. Measurement of A line is from the basiocciput line to the largest size of adenoid. N line could be measured from the posterior-superior hard palate to the edge of anterior-inferior of sphenobasioccipital synchondrosis. Fujioka Ratio was result of A/N x 100%.[11](Figure1)



a b

Figure1.a, b. Normal children AN ratio : 0.583 (0.499-0.621; SD +0.0741)
Children for adenoidectomy: 0.713 (0.652-0.853; SD +0.105).[11, 12]

Narrowing of pharyngeal space could be caused also by thickening of posterior pharyngeal wall and small space behind soft palate. Nasopharyngeal space could be measured as McNamara line. This line is measurement of upper pharynx, the closest distance of the edge of adenoid to posterior soft palate. This line also means the minimum distance from adenoid to the soft palate; mean: 15-20 mm; <= 2-5 mm means nasal respiration obstruction caused by adenoid.[12](Figure2)

The research proposal had carefully reviewed and approved by the Committee of The Medical Research Ethics of the Faculty of Medicine, University of Indonesia, with regards of the protection of human rights and welfare in medical research, with No: 112/PTO2. FK/ETIK/2002. *Ethical Clearance* of this study was approved by *informed consent* of the subjects.

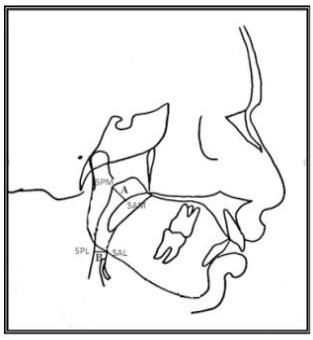


Figure 2. Upper pharyngeal width (lateral, normal): female 17 mm (SD 3,4 mm); male 20 mm (SD 4,3 mm); <= 2-5 mm means upper airway obstruction. Lower pharyngeal width (normal): female 11-14 mm; 11,3 mm (SD 3,3 mm); male 13,5 mm (SD 4,3 mm).[13]

Results

A valid and reliable questionnaire was used to detect OURT. The whole questionnaire could be trusted with Cronbach alpha values between 0.7-0.9 and r value was 0.51 to 0.75 and from 0.76 to 1.00 at the correlation between items.[1]

Variables	12 -15		9 -11	
	n	%	n	%
Apnea	129	78.18	46	38.33
No Apnea	36	21.82	74	61.66
Snoring	55	33.33	78	65
No Snoring	110	66.66	42	35

Table 1. The frequency distribution of subjects using the variables of apnea and snoring based on age category.

The number of OURT subjects were 285. All the subject were divided in to two group of age, first group was 12-15 years old (165 subjects), and the second was 9-11 years old (120 subjecs).(Table1). All subject was diagnosed snoring or sleep apnea experience when sleeping.

The group of OURT subjects without apnea/snoring (as control group) and the group of OURT subjects without apnea/snoring (as case group)were the two types of group that would be compared to see whether there were any differences in the clinical impact of OURT risks (Fujioka ratio and McNamara modification line). Table 2 showed the description of Fujioka ratio according to the clinical risks of OURT, which are apnea and snoring in case and control groups. There were no significant differences.

Age (year)	n	12-15 mean	Sd	p
Apnea	36	0.712	0.080	0.822
No apnea	129	0.708	0.093	
Snoring	55	0.726	0.102	0.113
No Snoring	110	0.701	0.083	

Note: *p<0.05

Table2.a. The value of Fujioka ratio using the variables of apnea and snoring based on 12 - 15 age category.

Age (year)	n	9-11 mean	Sd	p
Apnea	46	0.748	0.082	0.401
No apnea	74	0.734	0.093	
Snoring	78	0.749	0.104	0.088
No snoring	42	0.721	0.089	

Note: *p<0.05

Table2.b. The value of Fujioka ratio using the variables of apnea and snoring based on 9 - 11 age category.

Age (year)	n	*12-15* mean	Sd	p
Apnea	36	7.513	2.285	0.825
No Apnea	129	6.628	1.975	
Snoring	55	6.456	2.090	0.000
No Snoring	110	8.154	2.151	

Note: *p<0.05

Table 3.a. The value of Mc Namara line using the variables of apnea and snoring based on 12 -15 age category. Note: *p<0.05.

Age (year)	n	9-11 mean	Sd	p
Apnea	46	6.834	1.853	0.565
No Apnea	74	6.628	1.975	
Snoring	**78**	**6.296**	**1.803**	**0.001**
No Snoring	**42**	**7.469**	**1.929**	

Note: *p<0.05

Table 3.b. The value of Mc Namara line using the variables of apnea and snoring based on 9 - 11 age category. Note: *p<0.05.

McNamara line is the closest distance of the edge of adenoid to posterior soft palate. The most narrow of upper pharynx in this all subject were the closest distance between posterior wall of upper pharynx to the end of the soft palate. Therefore we called it the McNamara modification line. Table 3 showed the description of McNamara modification line according to the clinical risks of OURT, which are apnea and snoring in case and control groups. McNamara modification line on subjects that experience snoring during sleep shows that there was a significant difference (p=0.000 for 12-15 age group; p=0.001 for 9-11 age group).

Variable	Category	No Apnea		Apnea		P Pearson
		n	%	n	%	
Age 12-15						
Fujioka Ratio	Normal	4	3.1	0	0.0	0.285
	>Normal	125	96.9	36	100.0	
	<Normal	0	0.0	0	0.0	
McNamara modification line	Normal	28	21.7	5	13.9	0.384
	>Normal	1	0.8	1	2.8	
	<Normal	100	77.5	30	83.3	
Age 9-11						
Fujioka Ratio	Normal	1	1.4	0	0.0	0.531
	>Normal	72	97.3	46	100.0	
	<Normal	1	1.4	0	0.0	
McNamara modification line	Normal	4	5.4	4	8.7	0.482
	>Normal	0	0.0	0	0.0	
	<Normal	70	94.6	42	91.3	

Note: *p<0.05

Table 4. Distribution of group with apnea and group with no apnea by using Fujioka ratio and McNamara modification line on age groups in OURT patients Jakarta 2003-2005. Note: *p<0.05.

The Table 4 showed the control group, the group with subjects who had no apnea experience and the case group, the group with subjects who had apnea experience were two groups of subjects being observed for the relation between OURT risk factors in Fujioka ratio and OURT risk factors in McNamara modification line with apnea as the clinical impact. The analysis used Chi test. It was shown that there is no relation between Fujioka ratio and McNamara modification line with the apnea suffered by OURT subjects in the two age groups.

The Table 5 showed the control group, the group with subjects who had no snoring experience and the case group, the group with subjects who had snoring experience were two groups of subjects being observed for the relation between OURT risk factors in Fujioka ratio and OURT risk factors in McNamara modification line with snoring as the clinical impact. The analysis used Chi test.

Variable	Category	No snoring		Snoring		To-tal	P Pearson
		n	%	n	%		
Age 12-15							
Fujioka ratio	Normal	1	0.9	3	5.5	4	0.074
	>Normal	109	99.1	52	94.5	161	
	<Normal	0	0.0	0	0.0	0	
McNamara modif line	**Normal**	**29**	**26.4**	**4**	**7.3**	**33**	**0.008***
	>Normal	**2**	**1.8**	**0**	**0.0**	**2**	
	<Normal	**79**	**71.8**	**51**	**92.7**	**130**	
Age 9-11							
Fujioka ratio	Normal	0	0.0	1	1.3	1	0.301
	>Normal	41	97.6	77	98.7	118	
	<Normal	1	2.4	0	0.0	1	
McNamara modif line	Normal	5	11.9	3	3.8	8	0.091
	>Normal	0	0.0	0	0.0	0	
	<Normal	37	88.1	75	96.2	112	

Note: *p<0.05

Table 5. Distribution of group with snoring subjects and group with no snoring subjects with the Fujioka ratio and McNamara modifcation line based on age groups in OURT patients Jakarta 2003-2005. Note: *p<0.05.

It was shown that there was no relation between snoring with Fujioka ratio in the two age groups. Meanwhile, in McNamara modification line, there was a relation between McNamara modification line with snoring experienced by OURT subjects in age group 12-15 years, but not with age group 9-11 years.

Discussion

This research was conducted in Jakarta metropolitan city and it's viccinity with crowded transportation, surrounded by industrial areas could be a risk factor for upper respiratory tract infection for the population that can cause OURT. Thus the symptoms of snoring and apnea while sleeping was very likely to occur in the metropolitan society. This was indeed a

symptoms of OSAS (Obstructive Sleep Apnea Syndrome). This study analyzed the relationship of nasopharynx obstruction by the incidence of snoring and sleep apnea. The two parameter of sleep were detected using the measuring instrument a questionnaire.

Table 1 showed the number of subject experiencing apnea were more on age groups 9-11 years (38,33%) than in the age group of 12-15 years (21,82%). Similarly on variable experience snoring while sleep the number of group subject age 9-11 years (65%) were more than in the group subject 12-15 years (33,33%). This was most likely because at this age the adenoid gland of the subject with still enlarged, thus the nasopharynx lumen was small. This adenoidal gland generally would shrink at the age of 13.

This research showed that Fujioka ratio on the subject of OURT experiencing apnea and snoring while sleeping when compared on a case and control groups did not differ well on the age category 9 - 11 and 12 -15 years (Table 2). The study also showed that there was no relationship between the Fujioka ratio with snoring and apnea symptoms experienced by the subject of the OURT at both age groups (table 4). Lateral cephalograph picture showed the area of adenoidal problems on lumen nasopharynx, visible still broad enough for air flow of inspiration and expiration. While the measurement of the McNamara Line on a narrow nasopharynx area due to the position and inclination to the posterior of the soft palate.

Subject with OURT experiencing apnea during sleep indicates that the McNamara modification line when compared on cases and controls did not differ ($p>0.05$); both on the age category 9 - 11 ($p=0.565$) and 12 - 15 years ($p=0.825$) (Table 3). While the McNamara modification line on the subject that snoring during sleep when compared on a case and control showed significant different means ($p < 0.05$); both on the age category 9 – 11 ($p=0.001$) and 12 - 15 years ($p=0.000$) (Table 3). The study also shows there was no relationship between the McNamara modification line with apnea experienced by the subject of the OURT at both age groups (Table 4).

There was relationship between McNamara modification line of snoring subject and no snoring subject on in the age group 9 -11 years, while in age group 12 - 15 years, there was no relationship.(Table 5)

It seems no correlation between apnea and the Fujioka ratio or and McNamara modification line. Phillips from Alaska Sleep Educational Center expressed his opinion that enlarged tonsils and adenoids are a leading cause of snoring in children, and a strong indication of potential obstructive sleep apnea. The swollen glands aid in blocking the airways making it difficult for a child to breath comfortably through the night. [13] Therefore it's important to detect snoring and apnea early, so are needed a simple and cheap to detect snoring and apnea, for example, a simple questionnaire, valid, easy and reliable. Recently, Chervin and colleagues developed a more comprehensive questionnaires, expected more useful and accurate for research purposes.[14]

The Fujioka ratio of this research was no relation with the symptoms of snoring during sleep was detected by using the questionnaire as measuring instrument. Have not yet known how the research results when done on different populations, different inclusion and exclusion criteria, e.g. age or race is different. Although there was large Fujioka Ratio measurement, which means that there was hypertrophy adenoidal problems, and large nasopharynx lumen, air flow was large enough so that it doesn't happen the symptoms of snoring during sleep. If the Fujioka ratio was large and lumen nasopharynx was small, symptom of snoring might be occur while sleeping.

The pharyngeal lumen dimensions is an important factor in the occurrence of the symptoms of sleep apnea. On this research, there was no correlation between McNamara modification line and the symptoms of snoring while sleeping on a group of subjects aged 9 - 11 years, while on the subject of age group 12 - 15 years there was significant correlation. This can be explained, that a person who suffers OURT then evolved into a bad habit of sleep snore, depending on individual neuromuscular reaction in anticipation of the presence of airway obstruction. Neuromuscular reaction may occur in a manner to uphold the position of the head. This makes inclination servical bone towards cranial base enlarged. It seems that this inclination changes began in the second servical so it cause the lumen of against nasopharynx become narrow. In the younger age group (9 - 11 years) the subject can still adapt to the presence of airway obstruction or changes the position of

the head is still mild, but in the older age group (12 - 15 years) change the posture of the head more clearly so as to increase the severity of narrowing of the lumen of the nasopharynx in these regions. When air of inspiration flows through the inspiration of the narrow nasopharynx lumen then nasopharynx wall vibrations may occur.

Young Min Ahn from Korea Children explained snoring regularly generally have a narrow upper respiratory tract due to enlarged tonsil and adenoid, and have narrow maxilla compared to children who do not snore. Obstructive sleep apnea (OSA) in children is a frequent disease for which optimal diagnostic methods are still being defined. Treatment of OSA in children should include providing space, improving craniofacial growth, resolving all symptoms, and preventing the development of the disease in the adult years. Adenotonsillectomy (T&A) has been the treatment of choice and thought to solve young patient's OSA problem, which is not the case for most adults.[15]

All of these factors lead to nasopharynx lumen narrowing, make the sound of snoring. Thus the measurement McNamara modification line is very important. Measurement of this line in this research is the shortest distance from the posterior wall of the nasopharynx to the posterior wall of the soft palate. In observations on the lateral cephalograph, this line turned out to be a majority of its location on a third of the distal tip of the soft palate is not as portrayed by McNamara, i.e. lumen who are dealing with the adenoidal problems, so the researchers refer to this as the McNamara modification line .

Zee, a Professor of Neurology at Northwestern University's Feinberg School of Medicine explained a lot of evidence that shows there is a very strong relationship between the sleep quality and mental and physical health. Nachin, a senior advisor of the Scientific Coordination and Outreach at the U.S. National Center for Complimentary and Alternative Medicine observed that a lot of people experiencing sleeping problems and seek treatment. Sleep problems often associated with high blood pressure, anxiety and depression, according to a national survey of United States against 31,044 adults.[16] According to Rubin the worse their breathing symptoms, the greater their risk of such problems as hyperactivity, behavioral problems including aggressiveness and rule-breaking, anxiety and depression, and difficulty getting along with peers.[17,8]

Peppard *et al*. (cit. Zee & Nachin) research conducted at the University of Wisconsin showed that people who have abnormalities of breathing during sleep, often marked by a cessation of breath, gasping breaths or more slowly at night, have a 2.6 times tendency to suffer from depression. The chances of the emergence of depression increases along with the increasing severity of the abnormalities of breathing.[16]

Obstruction or blockage of the airway, it may cause a variety of symptoms such as snoring while sleep, mouth breathing habit, Obstruction Sleep Apnea or OSA. The impact of other deviations dentocraniofacial and low self esteem. Cardiovascular abnormalities might be occured in severe cases. Some one with severe apnea syndrome might be occured sudden dead. Since we know these symptoms are harmful to the subject who suffers it is necessary prevention efforts against the occurrence of OURT and MB. Early detection, diagnosis, and treatment are also very important.

Conclusions

Fujioka ratio on the subject of OURT experiencing apnea and snoring while sleeping when compared on a case and control groups did not differ in this research both on the two age group. The study also showed that there was no relationship between the ratio of Fujioka with snoring and apnea symptoms experienced by the subject of the OURT at both age groups. McNamara modification line on OURT subjects showed significant difference between snoring and no snoring during sleep, both in the two age group. There was a relation between McNamara modification line with snoring experienced by OURT subjects in age group 12-15 years, but not in age group 9-11 years.

It would be as important as the health of nasopharynx that support respiratory function so that someone could have a good sleep. This was evident from the results of research and discussion above.

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Declaration of Interest

The authors report no conflict of interest.

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