

Comparing Caries Experience between *Azadirachta indica* Chewing Stick Users and Toothbrush Users among 35-44-Year-Old Rural Population of Southern India

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ABSTRACT

Objectives: To compare the caries experience between *Azadirachta indica* chewing stick users and toothbrush users among 35-44-year-old rural population in Southern India. **Materials and Methods:** This *ex post facto* research was conducted in the rural parts of two sub-administrative areas of a district in the Southern Indian state of Andhra Pradesh. The sample size for the study was determined to be 400, with 200 subjects in each group. Subjects following indigenous oral hygiene methods were identified using an interviewer-administered questionnaire. After obtaining 200 subjects using *A. indica* chewing sticks, age, gender, and socioeconomic status matched controls using toothbrush were identified. American Dental Association type III examination was carried out to record caries experience (decayed missing filled teeth (DMFT) Index) after obtaining informed consent and thus obtained data were subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS) software, version 20. **Results:** It was observed that the caries experience was more in toothbrush users compared to subjects following indigenous methods (DMFT, 4.38 ± 1.93 vs. 3.54 ± 1.02). Similar results were obtained when the decay component of DMFT index was exclusively compared. No significant difference in the plaque scores and the mean number of filled, missing teeth was observed between the two groups. **Conclusion:** Though conclusive results cannot be drawn from this study about the positive influence of indigenous methods on caries experience, the results emphasize the cardinal need to more thoroughly understand the potential benefits of indigenous methods before dismissing them as retrogressive approaches.

KEYWORDS: Caries experience, indigenous, oral hygiene, tooth brushing

INTRODUCTION

Despite enormous scientific progress in the past few decades, there are people who follow health-care practices based on the knowledge they gained by virtue of practical engagement in day-to-day life. This knowledge, though not often backed up by scientific evidence, conventionally is a result of rational reasoning over generations and continues to exist in the cultures of its origin.^[1] India being a country with large ethnic society and huge biodiversity, it is not uncommon to find indigenous health-care practices and the magnitude of these primordial practices only

increases with regard to oral health care. Although such oral health-care practices possess strong cultural and economic justifications, it is more important to determine whether these indigenous methods of oral health care have positive oral health outcomes.

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India has an ancient history of using traditional oral hygiene methods. *Charaka Samhita*, an Ayurvedic medicine treatise, describes two types of mouthwashes, namely *Gandoosha* and *Kavalagra*, the use of which were common.^[2] Various forms of indigenous oral hygiene practices include the use of salt, charcoal, ash, cool tea leaves, lotus leaves, tea polyphenols, coconut leaves, sunflower oil, and a variety of chewing sticks.^[3] History suggests that Babylonians used chewing sticks 7000 years ago. The use of this oral hygiene method is still prevalent in some countries.^[4-6] Use of chewing sticks was also a routine practice in rural India since ancient times. Conventionally used chewing sticks are obtained from *Acacia arabica* (babul), *Psidium guajava* (guava), *Azadirachta indica* (neem), *Mangifera indica* (mango), and *Salvadora persica* (miswak). These sticks are reckoned to be effective in increasing the salivation and assisting in the expulsion of oral microorganisms. The affordable nature of the traditional oral hygiene practices, locally discussed benefits such as exercise for masticatory complex led to the increased use of these practices, especially in rural areas. In case of *A. indica*, nimbodin, azadirachtin, and nimbinin are active compounds responsible for antibacterial activity. *A. indica* also shows antifungal, anti-ulcer, and antinociceptive activity. The leaves and the bark extract of the tree are good sources of antioxidants and boosts the immune response in gingiva and oral tissues.^[7] There are 300 structurally distinct constituents in neem, majority of which are limonoids that manifest their effects by modulating multiple cell signaling pathways.^[8] The phytochemicals of *A. indica* have multiple advantages including prevention of noncommunicable diseases such as cancer, cardiovascular disease, and diabetes.^[9] Neem seed oil is reported to be used in cosmetics, toothpastes, and soaps.^[10] The World Health Organization (WHO) has suggested the use of these chewing sticks as effective tools for oral hygiene, and the influence of chewing sticks on aerobic and anaerobic microorganisms has been studied. However, it is said that the traditional preferences determine the choice of these sticks than clinical effectiveness.^[11] In this context, it becomes important to know the effectiveness of indigenous oral hygiene practices in reducing plaque accumulation and caries incidence as compared to that of toothbrush users.

With this background, the objective of this study was to document the differences in oral hygiene and caries experience between subjects using *A. indica* chewing sticks and modern oral hygiene practices.

MATERIALS AND METHODS

This *ex post facto* research was conducted in the rural parts of two sub-administrative areas of a district

in the Southern Indian state of Andhra Pradesh having access to oral health care at a teaching dental institution located within 15 km distance from these areas. Transect walks were conducted in the rural parts of the aforementioned administrative divisions before drawing the study protocol. It was observed that those people who regularly use toothbrush resort to use of chewing sticks occasionally during agricultural labor. It was concluded that occasional users of chewing sticks would not be included in the study. No other forms of indigenous oral hygiene practices were considered in this study as *A. indica* chewing stick was the most exclusive indigenous oral hygiene practice in the study area.

The institutional review board of the teaching dental institution with protocol number 180/IEC/SIBAR/2018 approved the study. Sample size was determined based on the results of a pilot study conducted in the study area with caries experience as the dichotomous dependent variable. Sample size to be obtained was 400 with 200 participants each from the indigenous and toothbrush groups. House-to-house survey was conducted in the study region during the months of January to February 2018, to inquire about the oral hygiene practices of the people aged 35–44 years. The basis for the selection of the age group was that the age group was recommended as the standard monitoring group for health conditions of adults and the full effect of dental caries and the level of severe periodontal involvement. Subjects with severe medically compromising conditions and those who were not local to the study area were excluded from the study. Informed consent was obtained from all the participants who satisfied the inclusion criteria before clinical examination. An interviewer-administered questionnaire was used to obtain the demographic data and the details regarding oral hygiene practices being followed. Socioeconomic status of the subjects was determined according to BG Prasad scale.^[12]

American Dental Association type III clinical examination was carried out by a single calibrated investigator to rule out the possibility of inter-examiner variability. Plaque index and decayed missing filled teeth (DMFT) index/WHO 1987 modification were recorded as the primary outcome variables. Caries experience scores were dichotomized with the target suggested by WHO/Federation Dentaire Internationale (World Dental Federation) by 2000 as reference (DMFT score, 3).

STATISTICAL ANALYSIS

Statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 20 (IBM, Armonk, NY) and Mann–Whitney *U* test, chi-square

test, and multiple linear regression were carried out to analyze the data.

RESULTS

Of the 400 subjects involved in the study, 184 (46%) were males. The mean age of the study participants was 39.42 ± 2.41 years and no significant differences were observed in the mean age between participants from *A. indica* chewing stick using group and toothbrush using group. No significant differences were observed in the socioeconomic status of the study subjects with 59.25% of people belonging to lower middle class (n = 237). Most of the study participants were agricultural laborers and share similar dietary habits.

No significant difference was found in the mean number of teeth present between the two groups. Table 1 shows the differences in plaque scores and caries experience scores between the two groups. Higher mean plaque scores were observed among toothbrush users compared to that among chewing stick users, though the difference was not statistically significant. A significant difference was observed in the mean caries experience between the study groups, with toothbrush users showing higher caries experience. When solitary components of DMFT were compared, no significant differences were observed between the groups except in mean number of decayed teeth.

Table 2 shows the difference in proportion of subjects having DMFT scores of more than 3 between the two

Table 1: Comparison of mean plaque scores, mean number of decayed, missing, and filled teeth as solitary scores and composite caries experience (DMFT) scores between toothbrush users and subjects using *Azadirachta indica* chewing stick

Variable	Type of oral hygiene practice		P value
	Toothbrush	<i>Azadirachta indica</i> chewing stick	
Mean plaque score	1.09 ± 0.26	0.87 ± 0.14	0.07
Mean no. of decayed teeth	2.28 ± 0.62	1.63 ± 0.49	0.013*
Mean no. of missing teeth	0.46 ± 0.18	0.39 ± 0.13	0.078
Mean no. of filled teeth	1.64 ± 0.32	1.52 ± 0.41	0.092
DMFT Score	4.38 ± 1.93	3.54 ± 1.02	0.001*

*P ≤ 0.05 considered statistically significant
Mann-Whitney U test
DMFT = decayed missing filled teeth

Table 2: Association between type of oral hygiene aid and caries experience

Group	DMFT score		Prevalence odds ratio	95% confidence interval (CI)	P value
	≤3 (%)	>3 (%)			
Toothbrush	81 (40.5)	119 (59.5)	1.908	1.21–3.46	0.002*
<i>Azadirachta indica</i> chewing stick	113 (56.5)	87 (43.5)			

*P ≤ 0.05 considered statistically significant
Chi-square test

Table 3: Influence of oral hygiene practices on caries experience, mean number of decayed, missing, filled teeth, and composite caries experience (DMFT)

Dependent variable	Oral hygiene practice	Exponent [β]	95% confidence interval	P value
DMFT	Toothbrush (with <i>Azadirachta indica</i> chewing stick as reference)	3.18	2.4–3.96	0.01*
	Plaque score	0.89	0.78–0.96	0.072
Decayed teeth	Toothbrush (with <i>Azadirachta indica</i> chewing stick as reference)	3.74	2.81–4.63	0.0012*
	Plaque score	1.82	1.26–2.38	0.046*
Missing teeth	Toothbrush (with <i>Azadirachta indica</i> chewing stick as reference)	1.46	0.81–2.02	0.08
	Plaque score	0.64	0.49–0.78	0.12
Filled teeth	Toothbrush (with <i>Azadirachta indica</i> chewing stick as reference)	1.302	0.63–1.93	0.094
	Plaque score	0.83	0.75–0.91	0.231

Multiple linear regression analysis
*P ≤ 0.05 considered statistically significant
DMFT = decayed missing filled teeth

groups. Table 3 shows the results of multiple linear regression with caries experience and components of caries experience as the continuous dependent variables, and type of oral hygiene practice and plaque scores as the independent variables. Subjects using toothbrush were found to be having higher incidence of decayed teeth and composite caries experience compared to those following indigenous oral hygiene measures.

DISCUSSION

It has been long acknowledged that dental caries has multi-factorial etiology. An attempt was made in this study to compare the exclusive influence of oral hygiene aid on caries experience by offsetting the other potential influential factors as people belonging to the same culture, geographical region, age group, equal access to oral health-care services, and who follow similar dietary practices were selected. *Ex post facto* research provides an opportunity to gain insights into the differences in outcomes between two naturally divided groups that have been observing a different routine, which could influence the outcome, for considerably longer period. This could be seen as a pragmatic alternative for experimental design in the determination of causal association, where conduct of experimental studies is not possible for ethical or practical reasons.

There is enough evidence in literature putting forth the antibacterial properties of *A. indica*. The antibacterial properties of *A. indica* against *Streptococcus mutans* and *Streptococcus feacalis* were reported by Siswomihardjo et al.^[13] Packia Lekshmi et al.^[14] advocated that chloroform extract of *A. indica* leaf inhibited *S. mutans* and *S. salivarius* and is useful against dental caries. Bhuiyan et al.^[15] discussed the bactericidal nature of acetone extract from *A. indica* bark against *S. sobrinus* and purported the anticariogenic properties of *A. indica*. It was observed that a mucoadhesive gel containing *A. indica* was superior to chlorhexidine gluconate mouthwash in reducing plaque index and salivary bacterial counts.^[16] A tree, which is extensively used in Ayurvedic, homeopathic, and Unani medicine, *A. indica* is now being described as a wonder tree of modern medicine as well in view of the aforementioned antibactericidal properties together with its antihyperglycemic, anti-inflammatory, antioxidant, and immunomodulatory properties.^[17]

Findings of this study highlight the nonsignificant differences between toothbrush users and those using *A. indica* chewing sticks in the primary outcome of plaque scores. Even the caries experience evaluated using dichotomized DMFT scores, the other outcome

was slightly less among indigenous oral hygiene practices. Chewing sticks are commonly used oral hygiene aids across the globe. There are ranges of trees from which chewing sticks are routinely obtained based on the geographic region. In the study area, *A. indica* trees are ubiquitous, and though their chewing sticks are commercially available, subjects in this study procured chewing sticks from their surroundings. Use of chewing sticks is very prevalent in the rural areas and among tribal communities. Kadanakuppe and Bhat,^[18] in 2013, conducted a study in the Iruliga tribal community, Karnataka, India, and found that 79.8% of the Iruligas use chewing sticks. Only 0.03% reported using toothbrush in the aforementioned study, whereas 14.9% used finger with either rangoli powder, salt, or charcoal.

No differences were observed in this study in the proportion of males and females between chewing stick users and the toothbrush users. Kahar et al.,^[19] in 2016, reported that males resort to indigenous oral hygiene practices with increased frequency compared to females. Occupation of the subject may play a role in the choice of oral hygiene aid, with subjects from those occupations demanding early morning work away from home, resorting to indigenous oral hygiene practices more commonly. The contrasting finding observed in this study could be due to the fact that most of the study subjects were agricultural laborers regardless of gender.

No significant difference was observed in the plaque scores between the two groups. These findings were consistent with those reported by Bhambal et al.,^[20] 2011. Contrary to the alleged problems with chewing sticks that it may not be possible to access all the surfaces of whole dentition, studies suggest that chewing sticks are as effective as toothbrushes with regard to maintenance of oral hygiene.^[21]

In this study, caries experience was more among the subjects using toothbrush compared to those using *A. indica* chewing sticks. Ezoddini-Ardakani,^[22] in 2010, reported that the risk for dental caries was almost 10 times more among the subjects using toothbrush compared to those using chewing sticks. The low incidence of dental caries among chewing stick users had been attributed to the improved mechanical cleansing action of these sticks and the antimicrobial properties. Islam et al.^[23] published similar observations in 2007 attributing the low incidence of dental caries to less plaque deposits among chewing stick users. Norton and Addy^[24] reported that the plaque scores and caries incidence were less among chewing stick users in their study conducted in Ghana, West Africa. Literature

suggests that chewing sticks from *A. indica*, miswak, babul, and so on, contain fluoride and could have the benefits of topical fluoride in remineralization of the teeth.^[25]

Though an abundance of literature comparing the mechanical cleansing properties of toothbrush and chewing sticks was available, differences in the incidence of dental caries between modern toothbrush users and those using chewing sticks was seldom reported. In this study, an attempt was made to compare the caries experience between the two oral hygiene methods. Plaque index was taken to rule out the confounding effect plaque scores could have on caries experience. DMFT index was used to record the caries experience as elimination of “F” component may lead to spurious results, especially if the rate of utilization of dental services is different between these groups. Moreover, care was taken only to include those teeth that were filled as a consequence of decay under “F” component. The debate on inclusion of “M” component in DMFT owing to the unclear reasons for tooth loss is still open without consensus.^[26] A study by Mustafa *et al.*^[27] among participants from Saudi Arabia reported less caries incidence among miswak users compared to non-miswak (toothbrush) users. Another study conducted by Shetty *et al.*^[28] comparing the effect of commercially available tooth paste and herbal tooth paste (Munident) on *Streptococcus mutans* counts reported comparable findings in both the groups. However, toothbrush was used by participants in both the groups in the aforementioned study.

A study conducted by Sirisha *et al.*,^[29] in 2014, in the Guntur area on low socioeconomic adults revealed that 40.4% are using twig as an oral hygiene aid and the overall mean DMFT score was 3.69 ± 2.71 , which is on par with this study. Owing to the fact that subjects in either group belong to the same geographical area and have similar dietary habits, analysis of diet was not carried out.

Over the centuries, Indians have used indigenous methods of oral hygiene practices. If there is no harm due to these practices on oral tissues, such practices can be continued as they are well accepted by the community. However, randomized controlled trials are to be undertaken to establish both the clinical efficacy and to rule out the possible adverse effects with the use of indigenous oral hygiene aids. Though the type of toothpaste whether fluoridated or non-fluoridated was not documented in this study, a pilot study in the study area revealed that almost all the toothpastes being used among the study population are fluoridated. However, this potential moderating effect of fluoride in toothpaste

would be offset by the fluoride- and calcium-releasing properties of the chewing sticks. The limitations of the study are that periodontal status was not considered and examination for dental caries was limited to the coronal portions of teeth using DMFT index. Future research needs to focus on differences in periodontal health and the occurrence of wasting diseases of teeth between chewing stick users and toothbrush users.

CONCLUSION

The use of indigenous oral hygiene methods, though might have reduced over the years, continues to be observed by considerable number of people in the rural areas. Although conclusive results cannot be drawn from this study about the positive influence of indigenous methods on caries experience, the results emphasize the cardinal need to more thoroughly understand the potential benefits of indigenous methods before dismissing them as retrogressive approaches.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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