



ORIGINAL ARTICLE

Efficacy of Rapid Antigen Detection Test For Group A *Streptococcus* in Bahraini and Non-Bahraini Children: A Retrospective Study

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Received date: August 6, 2020; **Accepted date:** November 24, 2020; **Published date:** December 31, 2020

Abstract

Background: Group A *Streptococcus* (GAS) is accountable for 20-40% of pharyngitis in children. Rapid antigen detection test (RADT) provides important information for determining the need for antibiotics for patients presenting with GAS infections. As compared to the throat culture technique, RADT offers a quick diagnosis within 5 to 10 min. The study aims to assess the efficacy of RADT in comparison with conventional throat culture for the detection of GAS using clinical samples from pediatric patients.

Methods: A retrospective study was carried out on pediatric patients of both genders aged up to 14 years, for a duration of five years at a tertiary care hospital of Bahrain. Tests such as RADT and throat culture were used for the analysis of throat swabs from these patients. Diagnostic performance characteristics were evaluated with conventional culture as the reference standard.

Results: A total of 1085 samples were collected from patients belonging to different age groups out of which, 232 were culture-positive and 234 were RADT positive. Majority of the culture-positive samples came from patients aged 5-9 y. The diagnostic characteristics test for RADT showed 90% sensitivity, 97% specificity, and 96% accuracy. The positive and negative predictive values were 89% and 97.30%.

Conclusion: RADT is an efficient, reliable, highly specific, and sensitive technique which gives rapid results to rule out GAS in pediatric patients in contrast to the conventional throat culture assessment methods, thereby enabling the clinicians to take a better clinical decision and limiting the unnecessary use of antibiotics.

Keywords: Sensitivity; Specificity; Sore Throat; *Streptococcus*; RADT

Introduction

Throat and other skin infections caused by Group A *Streptococcus* (GAS) are estimated to account for 20-40% of pharyngitis cases in children and 5-15% in adults all over the world.¹

GAS takes 2 to 5 days to incubate and spreads mostly via air. Symptoms such as pyrexia, headache, nausea, vomiting, and abdominal pain might be seen especially among children.^{2,3} In children, the clinical prediction rules for GAS are unreliable

if the etiology of the disease-causing organism is not clear.⁴ The signs and symptoms also vary and therefore, most guidelines that recommend antibiotic treatment of GAS also suggest confirmation of the presence of GAS on the basis of a throat swab culture.^{2,3} Although the infection can be confirmed by either throat culture or RADT, the latter technique is preferred as throat culture, despite being the standard method of diagnosis, has low specificity towards GAS organisms.⁴

Throat culture with a blood agar plate (BAP) is a method for diagnosis of pharyngitis caused by GAS.⁵ The major advantage of laboratory throat culture is its detection of GAS from swabs with a very low number of bacteria, but the major limitation is the 48-h delay in obtaining results.⁶⁻⁸ RADT provides important information for the antibiotic decision-making for patients presenting with throat infections. This test was developed to facilitate the physicians in detecting the presence/absence of GAS in very short time in patients with pharyngitis.⁹ It provides immediate results and is calibrated to produce positive or negative results. However, there is a lack of concurrence on the method suitable for detecting GAS in minors as the standard practice of treatment varies from country to country.¹⁰ Like in a study, McIsaac scores was calculated to separately estimate the pretest clinical likelihood of GAS pharyngitis for visits at which the RADT result was positive and for visits at which the result proved to be false-negative. Positive RADT results were assumed to be true positives, and test sensitivity was estimated by dividing the number of positive results by the sum of positives and false-negatives.¹¹ In another study, duplicate throat swabs were taken simultaneously from each patient. One of them was used for RADT achievement and the other for culture. When cultures were positive, a semi-quantitative evaluation was done. RADTs have been compared with BAP cultures as the criterion standard. However, these comparisons are complicated by the fact that there is no universally accepted procedure for performing a BAP culture.¹² The great majority of the RADTs that are currently available have a high specificity (i.e., 95% or greater) and a sensitivity of between 70 and 90% compared with BAP cultures.¹³ Few published

studies have compared the performance of various RADTs to each other or examined the performance of various RADTs in the office setting.^{14,15}

Therefore, we evaluated the diagnostic sensitivity, specificity, and accuracy of RADT for better diagnosis in pediatric patients.

Materials and Methods

This was an epidemiological study conducted at a tertiary care hospital in Bahrain for 5 years. The study received approval from the Institutional ethical committee of Bahrain Specialist hospital. The study was conducted according to the ethical standards and with the declaration of Helsinki. Throat swabs received from pediatric patients of both genders up to the age of 14 years were included in the study. The throat swabs were used to diagnose the bacterial infection in the patients. Patients having history of antibiotics use two weeks prior to consultation and those whose parents were not willing to give consent for participation were excluded from the study. All the throat swabs which came for clinical examination at the tertiary care hospital were taken into consideration. The samples were divided based on gender and age groups (0-4 y, 5-9 y, and 10-14 y). The GAS infection was confirmed by throat culture and RADT. Two throat swabs were collected from each patient, one for RADT and one for culture. The samples were sent to the Bacteriology Lab where standard microbial maintenance norms and procedures were followed.

The specimen was plated on a 5% sheep agar plate and incubated anaerobically for 18-24 h. The incubation temperature was maintained at 36°C in a 5% CO₂ environment. Beta-hemolytic Streptococcus isolated from throat swab culture was identified using Streptococcus grouping latex.

RADT

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of RADT were assessed using culture as the gold standard method. The RADT procedure was carried out according to the manufacturer's instructions. The kits used had been stored at 4°C and were not used for testing until room temperature was attained. In order to extract the group A streptococcal

carbohydrate antigen, five drops of reagent A and five drops of reagent B were added to the test kit chamber, and the swab was then inserted. The swab was agitated and left to sit for 1 min to 5 min, removed halfway, and rotated against the chamber ribs to release liquid into the chamber. The chamber valve was subsequently opened to allow the liquid to flow from the chamber along a test strip to an indicator coated with antibody to the group A streptococcal antigen. At 5 min, the strip showed a red line in the control and test regions. Two distinct red lines indicated a positive result, while the appearance of a single red line in the control region was considered to be a negative test result. If the positive control line did not appear, then the test was considered invalid.

Statistical analysis

The statistical distributions according to age and gender were presented as numbers and percentage values. The sensitivity and specificity, accuracy, PPV, and NPV were calculated for all age groups in using software R i386 3.6.3 and advanced excel.

Results

A total of 1085 samples were included in the study, which comprised 50.86% male and 49.14% female

patients. The highest number of positive cultures (55.6%) was from patients in the age group of 5-9 y. There were 234 positive and 851 negative samples determined by RADT whereas 232 were culture-positive and 853 were culture-negative (Table 1). The overall sensitivity, specificity, and accuracy of RADT were 90%, 97.07%, 95.6%, respectively (Table 2).

The samples from patients in the 5-9 y age group demonstrated better sensitivity (91.47%) values whereas those from patients aged 10-14 yrs showed better specificity (99.22%). Accuracy was better in patients aged up to 4 y and also those in the 10-14 y age group (Table 3).

The PPV was 87.32%, 88.72%, and 96.97% for the 0-4 y, 5-9 y, and 10-14 y age groups. Correspondingly, the NPV was 98.23%, 96.59%, and 96.24%, respectively (Table 3). Our study findings show that the RADT was more efficient than the conventional throat culture method for the diagnosis of GAS in Pediatric patients. Early diagnosis of GAS infections is essential to prevent serious complications. Hence, RADT has enabled the treating physician to identify the specific organism causing infection giving an accurate and

Table 1: Distribution of participants based on age group and gender

	Sub-category	Total n (%)	Culture	
			Positive; n (%)	Negative; n (%)
Age (years)	0-4	466 (42.94)	69 (29.74)	397 (46.54)
	5-9	456 (42.02)	129 (55.6)	327 (38.34)
	10-14	163 (15.02)	34 (14.66)	129 (15.12)
	Mean±SD (years)	5.67±3.25	6.27±2.67	6±3
Gender	Male		118 (50.86)	-
	Female		114 (49.14)	-

Table 2: Throat culture and rapid antigen detection test (RADT results)

Positive	Culture		Diagnostic performance tests					
	Negative	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)	
RADT	Positive	209	25	234				
	Negative	23	828	851	90	97.07	95.58	89 97.30
	Total	232	853	1085				

NPV: Negative predictive value, PPV: Positive predictive value, RADT: Rapid antigen detection test

Table 3: Diagnostic characteristics for RADT according to age groups

Age (years)	RADT	Culture		Diagnostic performance tests				
		Positive	Negative	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
0-4	Positive	62	9	89.86	97.73	96.57	87.32	98.23
	Negative	7	388					
5-9	Positive	118	15	91.47	95.41	94.3	88.72	96.59
	Negative	11	312					
10-14	Positive	29	1	85.29	99.22	96.32	96.67%	96.24
	Negative	5	128					

NPV: Negative predictive value, PPV: Positive predictive value, RADT: Rapid antigen detection test

quick results. Since the technique is highly sensitive and specific in nature it has enabled the physicians to take therapeutic decision at an early stage. The study further concludes that the Specificity of the RADT is sufficient to limit the use of antibiotics. However in future, correlation of RADTs with the therapeutic adherence to the treatment regimen can be studied. Further, RADTs can be utilized in promoting the ‘antimicrobial stewardship’ in the outpatients with GAS infections.

Discussion

GAS is a gram-positive bacterium which causes a variety of disease conditions and complications.¹⁶ This study evaluated two tests for GAS on samples of pediatric population belonging to different age groups. The total clinical samples collected were 1085. RADT had sensitivity within the range of 82.73%-96.98% and specificity within 96.27%-99.2% range for the 0-4 y age group. The PPV was in the range of 79.58%-95.06% and NPV was 96.93%-99.53%. In a study conducted by Gurol et al, RADT showed a sensitivity of 70% and a specificity of 97.8%. The PPV was 90.3% and NPV was 91.8% in the 0-9 y age group.¹⁷ According to another study by Tanzet et al, the RADT sensitivity was reported to be 70% (range: 61%-80%) and specificity was 80% (range: 94%-99%).¹⁸

We found 234 cases of positive cultures and 851 negative cultures. The prevalence of positive cases from our study was found to be 21.56% comparable to the study by Stewart EH et al, who estimated GAS infection in the children around 20-40%.¹ The percentage of accuracy for both positive and negative cultures for RADT was checked, which

was found to be 96% whereas a study by Breese et al. indicated the percentage of accuracy to be approximately 75% and 77%, respectively.¹⁹

Based on the above findings, it can be inferred that the availability of tests with high specificity and sensitivity can help healthcare professionals in taking better and quick therapeutic decisions without the necessity of further confirmation with the culture test. This makes the RADT the best choice for identification of the organism, prompt treatment, and helps in reducing the risk of GAS infections.¹⁶⁻¹⁹

It is very important that accurate and quick diagnosis should be made for the identification of GAS as the symptoms of sore throat and infections may lead to serious life-threatening conditions if left unrecognized. It is recommended to use double throat swabs so that a maximum sensitivity and PPV by RADT method can be obtained.²⁰ RADT is a rapid method, which yields results in few minutes as compared to traditional throat cultures. Although throat culture is considered a gold standard, it does not enable clinicians in arriving at a decision quickly, as it takes 48 hrs to obtain the results. Throat cultures are indicated to rule out Strep C and Strep G known to cause pharyngitis which cannot be detected by RADT.²¹ RADT is recommended as an established method for a quick initiation of treatment. This method is also useful for preventing unnecessary use of antibiotics.¹⁰

This study had certain limitations. It did not focus on the use of antibiotics and the type of patients who should receive them, which could have helped in developing a better rationale for pharmacotherapy

and would decrease the resistance to antibiotics. Furthermore, this research can be expanded to calculate and validate the scores based on the signs and symptoms to avoid unnecessary prescribing of antibiotics.²¹

Although RADT showed better reliability with high specificity and sensitivity, throat culture is an imperative technique to diagnose GAS infection. However, RADT can be used for rapid diagnosis of the infection to avoid antibiotic misuse that might result in unavoidable resistance in bacteria other than GAS.

Conflict of interest: Authors declare that they do not have any conflict of interest to report.

Source of Funding Support: Nil

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