Reassessment of Widal test in the diagnosis of Typhoid Fever

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Abstract

This study was done on 3 group of population. Group 1 comprised 80 normal, healthy, non febrile individuals with a negative history for typhoid fever and no history of immunization against typhoid fever . Group 2 comprised 50 patient with a febrile illness rather than typhoid fever with also no history of typhoid fever and no history of immunization against typhoid fever. Group 3 comprised 18 patient with bacteriologically confirmed typhoid fever and by using a new statistical approach for the calculation of the cut off value for categorizing positive and negative Widal test, the cut off value for O titer was 1/104 and for H titer was 1/120

The result of this study in group 1 showed that the Widal test was positive in 38,7% for O titer and 40% for H titer, and the number of cases with a titer 1/320 was 7 cases for O titer and 11 cases for H titer . the result in group 2 showed that the Widal test was positive in 20 cases for O titer and from these cases . 7 cases with a titer of 1/320. While positive test for H titer was 23 cases and from these, 11 cases with a titer 1/320 . In group 3 the Widal test was positive in all cases for both O & H titers and the number of cases with a titer 1/320 was 15 cases for O and   12 cases for H. The sensitivity of Widal test for a titer 1/320 was 83.3% for O titer and 66.7% for H titer while the specificity was 61.7% for both O & H titer. We concluded from these study that there are high false positive rates of Widal test in normal population and in non typhoid fever , and Widal reaction in a titer 1/320 was found in many cases, and for these reasons the Widal test in the area endemic for typhoid fever provides minimal if any , diagnostic assistance, and a titer above 1/320 is suggested as a diagnostic value for salmonellae typhi infection .

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Introduction

Typhoid fever remains an important public health problem in many developing countries. It has been estimated that about 16,000,000 case occurs annually in the world, with more than 600,000 death [1].

Typhoid fever was first described accurately by French workers mainly Bretonneau who called the disease Dothienterite[2], Louis (1829)[1] in Paris described typhoid and clearly separate it from other causes of fever and related the clinical features to the lesion in the intestinal mesenteric lymph nodes, and spleen, Budd (1873)[1] provided evidence that bowel discharge were the main, water borne, mechanism of infection, Gaffky (1896)[2] first cultivated and isolated Salmonella typhi in pure culture from the spleen of

infected patient, Pfeiffer and kolle (1896)[2] in Germany, and Wright and Leishman (1900)[1] in England prepared the first vaccine for human use, Widal test was discovered by Widal and Gruher (1896)[3].

Typhoid fever is an acute systemic disease resulting from infection with Salmonella typhi which is gram negative, nonsporing rode, motile bacteria[4].

The disease is unique to human, it is characeraised by malaise, fever, abdominal discomfort, transient rash, splenomegaly, hepatomegaly, bradycardia, and leucopenia, the most prominent major complications are intestinal hemorrhage, and perforation[4].

The disease is classical example of enteric fever caused by Salmonella, however Enteric fever, similar to typhoid fever, can also be caused by other Salmonella serotypes and is termed paratyphoid fever[4].

In our community as in other parts of the developing countries, febrile illness other than typhoid are common, e.g., Brucellosis, Tuberculosis, Meningitis, Hepatitis, and certain other acute fevers with an overlapping clinical picture leading to diagnostic confusion[5].

Typhoid can be diagnosed with certainty only by isolation of Salmonella typhi from the blood, urine, feces, or other body fluids, this is often not possible in developing countries, where the disease is common and endemic, because bacteriological facilities are not available in many of the smaller hospitals, under these circumstances the diagnosis has to be made by the association of a clinical picture compatible with typhoid and a significant titer of agglutination antibodies in the blood against the H,

and/or, O antigen of Salmonella typhi (Widal test) [6].

The commonly used Widal test reaction is an agglutination test using bacterial suspensions of Salmonella typhi and Salmonella paratyphi A and B, treated to retain only the somatic (O) or flagellar (H) antigens, these are used to detect the corresponding antibodies in patient serum, the earliest serological response in acute typhoid fever is said to be arise in the titer of the O antibody, the H antibody usually develops more slowly but persists longer than O, towards the end of the first week of illness titers of either antibody may be as high as 1:160 but paired sera taken 4 to 5 days apart give more reliable information, as an acute infection they should show an obvious rise[7].

In many developing countries, however, over the past years, especially recently, several workers have expressed doubt as to the value of this well established test, Schroeder[8], in a review of the clinical interpretation and value of serological tests in the diagnosis of typhoid fever included that the tests are nonspecific, poorly standardized, and often confusing and difficult to interpret, Sen and Saxena[9], in a large study of 451 case of typhoid fever, found that a single Widal test more often produce an equivocal or wrong diagnosis than the correct one, Wicks et al[10] found the test to be completely negative in 26 of 123 patient (21.14%) with positive blood culture, and below their diagnostic level in a further 34 patient, Devillier et al[11] compared 4 commercially manufactured typhoid antigens and regularly found two to four folds difference with sera from the same patients. Large mean differences between O antigen titers were found when testing the same sera

with 2 standard antigens during vaccine field trials in British Guiana in 1960[8].

There are at least 6 reasons why the Widal test could give erroneous information.

Firstly, it is an immunological test, and as such it has to be done under carefully standardized conditions, variations in these, such as the use of poorly standardized or unstable agglutinable suspensions, could produce incorrect results, the Widal test done on the same serum in 4 European laboratories gave widely different results[11].

Secondly, since Salmonella typhi shares the same H and O antigens with many other Salmonella, a rise in titer of these antibodies is not specific for Salmonella typhi[12].

Thirdly, immune proteins other than those induced by Salmonella typhi could cross-react the agglutinable suspensions, such false positive have been reported in patients with active chronic hepatitis, and could possibly occur in other immunological states[13].

Fourthly, the significance of the results should be assessed against antibody titers found in normal population of that endemic area, would be constantly exposed to the organism, and whose resting antibody titer might well be higher than in those living in nonendemic area, since it has been claimed that Salmonella agglutinating antibodies may show a nonspecific rise as a result of a nontyphoidal fever, the significant titer should be decided on after a study of antibody level in patients with nontyphoidal fever who are resident in that area[12].

Fifthly, Salmonella agglutinins may not be produced because of a poor antigenic stimulus, a defect of antibody production, or because the organism is out of contact with the antibody producing system, e.g., in synovial fluid. Finally, previous inoculation with TAB (Typhoid, Paratyphoid A, and Paratyphoid B) vaccine, or a past attack of Typhoid fever would make the Widal test of no value, surprisingly this is not a major problem in countries where typhoid is endemic, since few in these areas have had TAB[10].

Other illnesses, some are viral, mimic typhoid fever, although typhoid fever is a treatable infection, the drug of choice is Chloramphenicol, a potentially toxic drug, is still considered by many Doctors to be the preferred antibiotic for treatment of typhoid fever, thus a high index of suspicion should exist prior to initiation of therapy, the clinical response to antibiotic is usually not helpful in differentiating typhoid fever from viral or other infection, since approximately 3-4 days of antibiotic are required to make the patient afebrile[14].

Aim of the Study

To find the significance and validity of Widal test in the diagnosis of typhoid fever (Sensitivity, Specificity, Prevalence, False positive rate, False negative rate, Positive predictive value, and Overall accuracy).

Materials and Methods

The Widal test was done in 3 groups of population in the medical ward and outpatient clinic in the University hospital of Saddam College of Medicine (Fig.1).

Group 1: Comprised 80 normal, healthy, nonfebrile individuals with negative history of typhoid and paratyphoid fever, and no history of immunization against typhoid and paratyphoid fever (control group).

Group 2: Fifty patient with a diagnosed febrile illness which was not Typhoid

and who had not previously had immunization against typhoid or paratyphoid fever, this group is consisted of patients with Respiratory infection (14), Urinary tract infection (9), Tuberculosis (4), Infective endocarditis (7), Connective tissue disease (4), Leukemia (6), Meningitis (4), and Brucellosis (2), blood culture was done to most of patients and revealed negative results for Salmonella typhi and Salmonella paratyphi.

Group 3: This group is consisted of 18 patient with bacteriologically proven typhoid fever, in whom Salmonella typhi was isolated from blood only, 7 males and 11 females, 8 cases were collected from the University hospital and 10 cases from Baaquba general hospital, from October 2000 – November 2001.

Widal test was done using Iraqi product of sera and vaccine institute, H and O antigen suspension, by using rapid slide method

The procedure by which the technician had done the rapid slide titration was as the following:

1. By using microtiter pipette or 0.2 ml pipette, deliver 0.08, 0.04, 0.02, 0.01, 0.005 ml of undiluted serum into a row of 3-4 cm diameter circles on a white title.

2. Add one-drop (0.04 ml) of the appropriate well-shaken suspension to each serum aliquot.

3. Mix by stirring for a few seconds with a wooden applicator stick proceeding from the highest dilution (0.005-0.08 ml) serum, spreading the contents to fill the circles.

4. Rotate the tile slowly and read agglutination test with serum dilutions of 1:20, 1:40, 1:80, 1:160, and 1:320 respectively.

Results

Hundred forty eight patients were included in this study during the time period extending from Oct.2000 to Nov.2001. They were divided into 3 basic groups. Those are the following:

Group1: Those people who were apparently healthy without a complaint (normal individuals) as a control group.

Group2: Includes the patients who were diagnosed clinically to have non-typhoid febrile illness.

Group3: Includes those febrile patient who were proved to have typhoid fever clinically and bacteriologically (positive blood culture) .

Age and sex:

Group1: Eighty patients were designed to be as a control group, 52 of them were males, and 28 of them were females, the mean age for the male group was 33.48 ± 2.03 year, with a range of 10-70 year, while females mean age was 34.66 ± 2.8 year with a range of 12-70 year.

Group2: The total number of patients included in this group was 50, divided into 29 males and 21 females, the mean age for the male patients was 35 ± 3.18 year with a range of 12-80 year, while the female patients with a mean of 37.17 ± 3.47 year, with a range of 6-70 year.

Group3: Eighteen patients had been confirmed bacteriologically to have typhoid fever, 7 of them were males with mean age 24.29 ± 3.35 year, and their range were 15-40 year, the rest of patients were females with mean age of 27.64 ± 2.09 year, and their range was 17-40 year (Table 1), this table shows that

the age effect in the three groups is statistically of no significant value between the mean age of male and female within each group, but it also shows that in the samples of group 3, the mean age of the male patient is lower than the rest groups mean which is statistically significant (24.29±3.35) and this is also applicable for the female patients of the same group.

In order to check the sex distribution in group 3 in comparison with group 1 and 2, Chi square test of significance with 2 degrees of freedom was conducted (Table 2).

Control group:

In group 1 who were considered as a control group for this study, analysis of Salmonella typhi antibody titers for both types (O and H) had been performed and shows that the Widal test in the normal individual was negative in 44 case (55%) for Salmonella typhi O, and 40 case for Salmonella typhi H (50%), while a positive Widal test was recorded also in this group with varying titer (1/80, 1/160, and 1/320), with mean titer of 1/81.2±11.4 for Salmonella typhi O Antibody and mean titer of 1/94.2±12.8 for Salmonella typhi H, (the distribution and observation is shown in Table 3).

Student t-test:

Analysis had been conducted to study the significant difference between the antibody titers (O and H) in the sample of group 1 and shows that there is no significant difference in the mean titer recorded for types of Salmonella typhi antibody.

Cut-off value:

In this study we tried here by the help of statistical analyses and the results of Widal test in the normal individuals (control group) to conclude a Cut-off value for the positive Widal test in the subsequent two groups which is 1/104 for Salmonella typhi O Antibody and 1/120 for Salmonella typhi H antibody and this value is representing the upper 95% confidence limit for each mean as described by Al-Murrani et al. 2000[15].

So application of this cut off value in this study for group 1 shows that 31 cases were carrying a positive Widal test for Salmonella typhi O antibody (≥ 1/104) (38.7%), while 32 cases were positive for Salmonella typhi H antibody (≥ 1/120) (40%) (figure 2).

In table (3), Chi square analysis showed no significant difference between the types of antibody regarding the negative test or the positive one (with all titers 1/80, 1/160, 1/320) as well as for any titer value in between. (P > 0.05)

Group2 Nontyphoid febrile illness:

In those febrile patients of non typhoid origin the Widal test results were also negative in 30 patient according the cut off value of this study (60%), while positive results seen in 20 patient (40%) for Salmonella typhi O, and from these, 7 cases with a titer equal to 1/320, yet for Salmonella typhi H antibody, 27 case were negative (54%) and the rest 23 cases were positive (46%), with 11 cases with a titer equal to 1/320.

Group 3 Typhoid fever:

In group 3 where the fever proved to be typhoid in origin, the widal test shown to be positive in all cases for both O&H titer, and from these (83.3%) presented with a titer equal to 1/320 for O titer, and (61.3%) for H titer. 12 patient presented in the first week of illness and 8 cases in the second week of illness.

Analysis variance performed for each antibody type titer in each group separately which showed no significant difference between them (table 4), while

there is highly statistical significant difference between the mean antibody titer of both types among the 3 groups (p < 0.0001) as the lowest mean titer was seen in the normal control group with a range between 91.2 and 94.2 for Salmonella typhi O and H respectively, while the titer in the febrile group came as a second mean titer of 115.9 & 125.7 respectively and the highest records were 294.4 &266.7 respectively that seen in positive culture typhoid fever which had antibody titers exceeded the cut off value of this study.

According to the results of this study in all three groups and depending on the Cut-off value verified here with the help of statistical formula in calculating the significance of Widal test in the diagnosis of typhoid fever, the sensitivity, specificity, false negative rate, false positive rate, positive predictive value, over all accuracy and prevalence of this positive test in the study, these parameters were applied for group 3 and also for both O and H antibody titer in level of 1/160 and 1/320 respectively.

In Table (5) the significance (prevalence, sensititvy, specificity, false negative rate, false positive rate, positive predictive value, and over all accuracy) of Widal test in the titer of 1/160 for both O and H titer in group 3 are shown.

Table (6) showed that the prevalence of the titer 1/320 was equal in this group for both O and H titer (18.4%). The sensitivity of Widal test in this titer was more for O (83.3%) titer than H titer (66.7%) while the specificity was equal for both O and H titer which was (61.2%). The false negative and false positive rates for both titers were similar (33.3%) and (38.8) respectively. The positive predictive value was 34.9% for

O titer and 27.9% for H titer, and the over all accuracy of H titer (62.2%) is more than for O titer.

Discussion

Sex and Age:

In this study the female to male ratio among the cases of typhoid fever was 1.5:1, with mean age of female 27.6±2.09, while mean age for male was 24.29±3.35, 33.3% of cases are within age group 20-29year.

This study does agree with Al-Rawi study (1992)[16], who showed that the female to male ratio was 1.4:1, and about the age distribution Hook and Gurron(1987)[4] had 75% of cases below age of 30 years.

Widal test:

A single rapid slide agglutination test was done for 3 groups of population (healthy group, non-typhoid fever group, and typhoid fever group).

In endemic area where the population would be exposed to Salmonella organisms, elevated antibody titers may be present in a significant proportion of the normal population.

There is no consensus in literatures concerning the diagnostic criteria for interpreting Widal test[8], in Iraq many studies were done and various Cut-off titers are stated, Al-Rawi (1992)[16] considered an initial titer of 1/320 is the most reliable one in the consideration of typhoid fever, Al-Abbasi(1993)[5] also considered an initial titer of 1/320 as diagnostic value, Saleh (1986)[17] mentioned that a titer 1/160 is highly specific but less sensitive in the community of Basrah, Hameed (1993)[18] also considered the titer of 1/320 for both O and H is of diagnostic value.

In this study we tried to find the Cut-off value (Point) for categorizing positive

and negative Widal test, in the case of O titer it was found to be 1/104, and 1/120 for H titer, these Cut-off values were calculated as the upper 95% confidence limit for each mean, as described by Al-Murrani et al (2000).[15]

We consider that the Cut-off value calculated in this study is more reliable and representative to Iraqi population compared to what have been already used in previous studies, because of high exposure of our community to different types of Salmonella infection during the life of people, though such kind of infection that might not be regarded or considered as clinical Typhoid fever, this might explain the high false positive percentage in normal population.

By application of this Cut-off value which is mentioned above, Widal test is positive in 31 case for Salmonella O titer (38.7%), and 32 cases are positive Widal test for Salmonella H titer, and from these, 18 case are positive for O and H antigen at a titer $\geq$ 1/320 (7 cases for O titer, and 11 case for H titer). Al-Abbasi[5] et al (1992) noticed that 42% of normal cases have positive Widal test in a titer $\leq$ 1/160 for both O and H antigens, El-Shafie[19] in Sudan also showed that 30 % of normal population have positive Widal test in a titer $\leq$ 1/320 and 10% from these with titer 1/320, Koelmann[20] in Holland had 11.3% false positive Widal test, also Tsarg (1981)[21] noticed 16% false positive reaction, while Quirago et al (1991)[22] in Chili showed 7.7% positive Widal reaction in a titer $\leq$ 1/160. There are many reasons for these findings in normal healthy population that explain the high titer, from these, Widal test is an immunological test and such tests has to be done under carefully standardized conditions, variations in

these, such as the use of poorly standardized or unstable agglutinable suspension could produce incorrect results, the Widal test done on the same serum in different European laboratories gave widely different results [6].

We believe that the high prevalence of antibodies in healthy Iraqi population implies widespread subclinical infection with Salmonella typhi, also Salmonella typhi shares the same O and H antigens with many other Salmonellae, a rise in titer of these antibodies is not specific for Salmonella typhi, another explanation for this false positive Widal test in normal population is that the reading of rapid slide agglutination test after 2 minutes can give a false result, or the suspension is not in room temperature.

About the Widal test in the Nontyphoidal febrile illness (group 2) and according to the Cut-off value for categorizing positive and negative Widal test, the positive Widal titer for O antigen was present in 20 case (40%) from which 7 cases with titer 1/320, and for H antigen 23 case (46%), from which 11 case with titer equal to 1/320.

Al-Abbasi et al (1992)[5] had in their study a positive Widal test in 26% of non-typhoid fever with titer for both O and H antigens $\leq$ 1/160, Al-Falluji (1993)[23] showed 8.3% positive Widal for O antigen and 11.6% for H antigen, and from these positive Widal tests 3.3% and 5% for both O and H antigens had a titer $\geq$ 1/320, Jhaver et al (1995)[24] noticed a positive test in 14.58% and 10.4% of malaria patients for both O and H antigens respectively, Skoutelie et al (1994)[25] noticed a very high titer of typhoid and paratyphoid agglutinin which were obtained with the Widal test in the immunotherapy with BCG for

bladder carcinoma, Quirago et al (1992)[22] showed 7.8% false positive Widal reaction for both O and H antigens titer in non-typhoid febrile patient, Senwiratne et al (1977)[6] also noticed 11.7% false positive Widal reaction in febrile patients with major immunological disturbance.

There are many causes or explanations for this false positive Widal test in our study in group 2, from these, that the immune proteins other than those induced by Salmonella typhi could cross-react with the agglutinable suspension, or it may be due to nonspecific polyclonal B lymphocytes stimulation due to infectious disease rather than typhoid fever like in malaria, is postulated to be responsible for this phenomena[24], also with that mentioned for the explanation of positive Widal test in normal healthy people can explain why positive Widal test occur in non-typhoid febrile patients.The Widal test in bacteriologically confirmed typhoid fever (group 3), and according to our Cut-off value for categorizing positive and negative Widal test, showed that all of the 18 patient had a positive reaction for both O and H antigens at a titer ≥ 1/160.Al-Abbasi et al (1992) had 79.1% positive Widal test, Al-Fuluji[23] had 96.6% positive Widal for O antigen and 53.3% for H antigen, Levin (1978) had 90% positive reaction, while SenWirante et al (1973) [6] noticed 94.3% positive Widal for both antigens.

The results of this study showed that a titer of 1/320 for O antigen is present in 83.3%, while 61.3% for H antigen, these reveal that a rising O titer is more significant or reliable for the diagnosis of typhoid fever, despite that we regard this titer of no diagnostic value, because these titers are present in high percentage of normal population and non-typhoid fever, this study shows that the O titer is more sensative than the H titer for the diagnosis of typhoid fever, these findings do agree with that reported by Schroeder[8], SenWirante et al[6], pang and puthucheary[26], and Shehabi[30], but differ from that reported by Wicks et al[10], Brodie[27], and somerville et al[28].

The results in this study show no cases with negative Widal test, which do not agree with that reported by other studies, Al-Abbasi et al[5] had 20% negative Widal test for O titer and 18% for H titer, Hameed[18] had 35.7% for O titer and 40% for H titer, these mainly due to the relatively small sample or it may be due to immunologically sensitized patient due to continuos exposure to Salmonella typhi and other Salmonellae species [26].

The well established criterion for the diagnosis of typhoid fever (showing four folds rise in titer) is not valid in this study, this finding can be explained by that many of our patients are presented late in the course of their illness and fever, so they have sustained peak antibody titer at the time of admission, and some of the patients might have had a response as a result of previous exposure in area endemic with typhoid fever.

This study shows that 12 patient with typhoid fever were presented in the first week of illness, and 6 patients were presented in the second week, classically Salmonella typhi agglutinin is raised to a diagnostic level during the second week of illness, however, the results show that in Iraq it can raise earlier to a diagnostic level even during the first week, as had also been observed by Wicks et al[10] in Rhodesia, this could be attributed to a

hyperimmune state in the population which is frequently exposed to typhoid.

In this study the characters of Widal test, at a titer equal to 1/160, are that the prevalence of positive test is 18.4% for both O and H titers, with a high sensitivity (100%), and relatively low specificity (61.3%), positive predictive value is 36.7% for both titers, and the overall accuracy is 50% for both titers.While for a titer of 1/320, the prevalence is 18.4% for both O and H titers, the sensitivity of O titer is 83.3%, but 66.7% for H titer, both titers show low specificity 61.21%, the positive predictive value is 34.9% and 27.9% for both O and H titers respectively, and the overall accuracy 43.9% and 62.2 % for both O and H titers respectively.

From these findings this study shows that the Widal test is of little diagnostic value even in a titer of 1/320, because this titer is also present in a high percentage in both normal healthy group and in non-typhoid febrile illness, Collard et al[28] have suggested that the titer of agglutinin considered to be significant should be such as would not be expected to be present in 5% of normal population, also Bokkenheuser et al[8] demonstrated that the False positive reaction rates of 6% to 8% minimizes the usefulness of this test as a general screening device.

Conclusions

1. High false positive rate of Widal test present in our healthy population and in non-typhoidal febrile illness.

2. Widal reaction in a titer of 1/320 was found in many cases of healthy population and non-typhoidal febrile illness.

3. The significance of the results of Widal test should be assessed against antibody titer found in the normal population of that environment.

4. Because of the high prevalence of antibody amongst healthy individuals in the area of highly endemic typhoid fever, a single Widal test provides minimal, if any, diagnostic assistance.

5. Negative Widal test would be more helpful by survey to rule out typhoid fever.

6. Widal test is not specific, less sensitive, confusing, and difficult to interpret.

7. Blood culture remains the most definite and mainstay diagnostic procedure of typhoid fever.

Recommendations:

1. If serological test is used, a titer >1/320 should be used as a significant value for the diagnosis of typhoid fever.

2. Making the facilities of blood culture readily available in all hospitals.

3. We need a simple, sensitive, specific, and rapid serological test, like ELISA, rather than Widal test in diagnosis of typhoid fever.
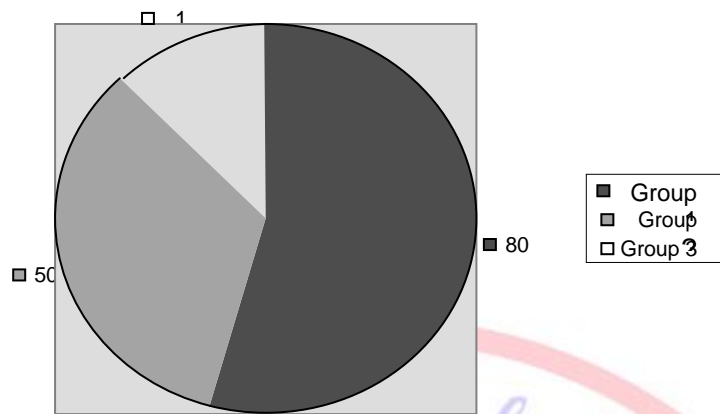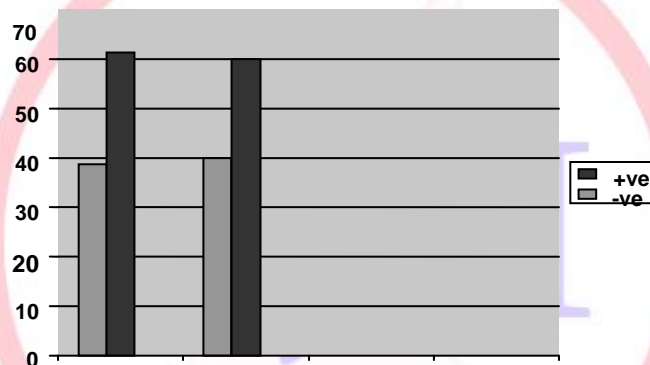
Appendix:

Fig.(1): Groups of population in the study.

Group 1: Normal

Group 2: Nontyphoid fever

Group 3: Typhoid fever

Salmonella typhi O & H

Fig. (2): Results of Widal test according to Cut off point.

Table (1): Grouping of the study sample according to their age and sex.

Group	N	Mean Age of Male	N	Mean Age of Female
1	52	$33.48 \pm 2.03_a$	28	$34.66 \pm 2.80_a$
2	29	$35.00 \pm 3.18_a$	21	$37.10 \pm 3.47_a$
3	7	$24.29 \pm 3.35_{bc}$	11	$27.64 \pm 2.09_c$

N= Number of observation.

Age $\chi \pm SEM$

N.B., Different letters between the cells denote significant different at LSD 5%.

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Table (2): Chi square analysis of sex distribution in the three groups.

Sex		Group 1	Group 2	Group 3	Total
Male	O	51	29	7	87
	E	47	29	11	
Female	O	29	21	11	61
	E	33	21	7	
		80	50	18	148

O= Observed values

E= expected value on the basis of chance (Null hypothesis)

$\chi^2_{df=2}$= 3.76

$P > 0.05$

Table(3): Results of Widal test in normal people.

Widal est Antibody titer		Salmonella typhi O		Salmonella typhi H	
Negative		N	%	N	%
		44	55	40	50
Positive	1/80	5	6.25	8	10
	1/160	24	30	21	26.25
	1/320	7	8.75	11	13.75

Table (4): Mean Antibody titer (O & H) in the 3 groups of sample.

Group	N	AB titer mean +/- SEM	
		Salmonella typhi O	Salmonella typhi H
1	80	81.2±11.4 a	94.2±12.8 a
2	50	115.9±16.3 a	125.7±16.8 a
3	18	294.4±13.9 a	266.7±18.3 a

Table (5): The significance of Widal test in titer of 1/160 in group 3.

Parameter	O titer	H titer
Prevalence	18.4%	18.4%
Sensitivity	100%	100%
Specificity	61.3%	61.3%
False negative rate	0%	0%
False positive rate	38.8%	38.8%
Positive predictive value	36.7%	36.7%
Over all accuracy	50%	50%

Table (6): The significance of Widal test in titer 1/320 of group 3.

Parameter	O titer	H titer
Prevalence	18.4%	18.4%
Sensitivity	83.3%	66.7%
Specificity	61.2%	61.2%
False negative rate	33.3%	33.3%
False positive rate	38.8%	38.8%
Positive predictive value	34.9%	27.9%
Over all accuracy	43.9%	62.2%

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