



## EVALUATION OF DIAGNOSTIC UTILITY OF FOLDSCOPE AGAINST CONVENTIONAL BRIGHT FIELD MICROSCOPY IN PATIENTS OF LOWER RESPIRATORY TRACT AND FUNGAL INFECTION IN TERTIARY CARE HOSPITAL.

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**ABSTRACT** Foldscope is a researcher tool in the diagnosis of bacterial and fungal pathogens. In various clinical settings, conventional light microscope is not available due to high cost, to overcome this problem we can use foldscope. In this Prospective Analytical study, twenty out of 45 cases were detected positive for microorganisms (like bacteria, fungal hyphae) by light Microscope. Out of 20 positive cases, 8 cases (wet mount stain) were positive by both scopes for fungal hyphae, 5 positive cases (Gram stain) were identified by light Microscope and negative by Foldscope. Seven positive cases (ZN stain) were identified by light Microscope and negative by Foldscope. Present study highlights the need of sensitization & training sessions regarding use of foldscope as an educational or research tool among the student's, for early diagnosis particularly in the rural and remote area and can therefore lead to better treatment.

**KEYWORDS :** Foldscope, Fungal Hyphae, Pathogenic Microorganisms

### INTRODUCTION

The Foldscope, an "ultra-low-cost-origami-based" portable microscope, is the brainchild of a group of engineers from Stanford university<sup>1</sup>. It was invented by Manu Prakash for use in remote areas to identify disease organisms.<sup>2</sup>

The Foldscope starts as a piece of die-cut plastic-coated paper with a small lens fix into the sheet. By following patterns on the paper, user can fold the sheet to assemble a featherweight hand held-microscope. A small LED light and battery mounted to microscope illuminate slides, and user can focus the image by flexing the microscope with their thumbs. When purchased in a production run of 10,000 scopes, the materials for a single microscope cost less than \$1.<sup>3</sup>

It was developed for usage by students and professionals all over the world in more serious research and diagnostic roles.<sup>4</sup>

Microscope is the most widely used method for detection of pathogenic organisms in clinically suspected cases of LRT and dermatophytes infections. One more advantage of Foldscope is its connection to cell phones to record images and videos<sup>5</sup>.

The purpose of this study was evaluation of diagnostic utility of foldscope against conventional bright field microscopy in patients of lower respiratory tract and dermatophytes (fungal infection) in tertiary care hospital.

### MATERIAL AND METHODS:-

This Prospective Analytical study was conducted in the Department of Microbiology, attached to a Tertiary Care Hospital in Central India Over a time period of two months from 1<sup>st</sup> August to 30<sup>th</sup> Sep 2019 after obtaining Ethical Clearance.

A Total of 45 samples were taken from clinically suspected cases presenting with signs and symptoms of LRTI in Pulmonary/ Medicine and fungal infection from skin OPD/IPD were enrolled for Prospective analytical study, like sputum, Broncho- alveolar lavage (BAL), Gastric lavage fluid, Plural effusion fluids, skin scrapings, infected hair and nails etc.

### COLLECTION OF SAMPLES:

Samples were collected from- Patients suspected to have LRTI in a sterile wide mouth container who routinely attended OPD/IPD (Pulmonary and Medicine)

Patients suspected to have fungal infection in a sterile wide mouth container or black dry paper or 10% KOH (2ml in a sterile test tube) who was routinely attended Skin OPD/IPD attached with a Tertiary care hospital.

All the specimens collected were transported immediately to the Microbiology laboratory for further processing.

### PROCEDURE FOR SAMPLING :

After receiving the sample, Three study slides were prepared from each sample (LRTI suspected sample), one for Gram staining (detection for non-acid fast bacilli and fungal hyphae) and other for ZN staining (detection for acid fast bacilli), and third slide was prepared for wet mount to detect the fungal hyphae in 10% KOH (in fungal infection suspected sample). After staining all study slides were observed under conventional light microscope and then under foldscope by two trained independent microbiologists (who will be blinded to each other results) to remove bias.

Slides were randomly reasserted after each evaluation & separate data capture forms was used by each evaluator to eliminate the possibility of first microbiologist's reading influencing the second.

### IMPLICATIONS:

The purpose of this study was planned to compare light microscope and foldscope for detection of microorganisms from clinical suspected cases of LRT and fungal infection from different staining methods like Gram/ZN staining/wet mount. We are looking for motivated individuals and teachers to take on a research or educational project that was benefit from the use of foldscopes.

Therefore this was to identify and describe how students, teachers and microbiologist respond to and are able to effectively use of foldscope to identify the infectious pathogenic organisms to provide better treatment in remote areas.

### OBSERVATION & RESULTS:

A total of 45 samples were collected out of which 25 samples were of sputum for LRTI and 20 were of skin scrapping for fungal infection detection after Institutional Ethics Committee Clearance.

Maximum number of patients were in the age group of 51 to 70 years (37%), followed by age group 10 to 30, 71-90 years (22%). There were only 8% patients who were 31-50 years. (Table-1)

Out of 45 patients studied 71% were males, while females constituted only 28%. (Table-2)

**Table No.1: Age wise distribution of Patients clinically suspected of LRT and fungal infection**

Age Group	No. Of patients	Percentage
10- 30	10	22.2
31 – 50	08	17.77
51 – 70	17	37.77
71 – 90	10	22.2
<b>Total</b>	<b>45</b>	<b>100.0</b>

**Table No.2 Sex wise Distribution of Patients clinically suspected of LRT and fungal infection**

Sex	No. of patients	Percentage
Male	32	71.11

Female	13	28.88
<b>Total</b>	<b>45</b>	<b>100.0</b>

**Table No. 3: Comparison the data visibility from Foldscope and Light microscope by different staining methods (Wet mount, Gram stain and ZN stain)**

Staining techniques performed	Type of sample	Light microscope (Clear/Not clear)	Foldscope (Clear/Not clear)
Wet Mount (n=20)	Skin scraping	Clear	Clear
Gram staining (n=10)	Sputum	Clear	Not clear
ZN staining(n=15)	Sputum	Clear	Not clear

The observation for wet mount, Gram stain and ZN stain for the samples collected were as given in Table 3.

Of 45 cases only 20 were detected positive for microorganisms (like bacteria as well as fungal hyphae) by light Microscope. Out of 20 positive cases, 8 (using wet mount stain) were positive by both scopes (Foldscope and light Microscope) for fungal hyphae, 5 positive cases (using Gram stain) were identified by light Microscope and negative by Foldscope. 7 positive cases (using ZN stain) were identified by light Microscope and negative by Foldscope. Fungal hyphae were identified by both scopes (Foldscope and light Microscope) using wet mount.

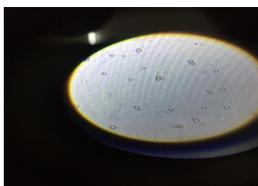
After analysis each capture image precisely, few specimen were shows structures which are analogous to characteristic morphology of fungi by both scopes. (Images 1 and 2)

#### Image 1 and 2 showing comparison in view by foldscope and light microscope

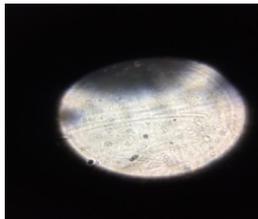
##### View in Light Microscope of Fungal Hyphae



##### View in Light Microscope of Budding yeast cells



##### View in Foldscope of Fungal Hyphae



##### View in Foldscope of Budding yeast cells



## DISCUSSION

Foldscope deserves the attention in the present context cause it's the only microscope that is made up of water-proof paper, ultra-light and low-cost. The extraordinary feature of this microscope is that it can be attached to the smartphone with a help of simple coupler and can be used to take the photos and videos in real time, which is a hard task in other microscopes<sup>[6]</sup> The foldscope has the variable magnification ranging from 140X to 200 X can be assembled in less than a minute.

As an increasing number of students have access to smartphones, they can document the samples that they observe. This allows for teachers to access the work that students are doing by having the students send their picture to teachers. Students can also share the pictures that they take with their peers.<sup>[2]</sup>

We observed in this study, Foldscope is the most frequently used tool for diagnosis of fungal infection by using Wet mount examination.

In study done by Lhanjy P.Wangdi, Arpan Pradhan *et al*<sup>[7]</sup> shows, out of the 25 cases, 8 cases were positive for fungal infection by wet mount examination with the help of Foldscope.

In our study, out of 45 samples, 20 cases were found to be positive by Light microscope using all technique (like Gram stain, ZN stain and wet mount technique). Only 8 were positive by Foldscope, which were fungal hyphae, the reason because of Foldscope provide magnification of 140x and 2 μm resolution, which is not sufficient to observe the bacteria (<2 μm in size) from foldscope. But we can observe the fungal hyphae (> 2 μm in size) at this magnification power.

As foldscope is new to present world of microbiology and much studies on similar topics are not done by other researchers. We have observed in this study that with future modifications (by usage of lens of higher magnification) foldscope may be useful diagnostic tool in clinical microbiology and early detection of disease in public health setting specially in rural and remote areas.

## CONCLUSION

The overall use of foldscope in LRT and fungal infection, conclude that foldscope was unable to detect the disease causing organism in sputum sample of LRTI patients due to its magnification of 140x and resolution (>2 μm) which is not the clinical diagnostic range for organisms who is less than 2 micron.

However positive results are found in case of fungal infection so, fungal elements/hyphae easily observed by foldscope.

Hence mobile phone mounted foldscope can be used for reliable identification of fungi. With future modifications, foldscope may be useful diagnostic tools in clinical microbiology to detect pathogenic organisms in public health setting.

Overall, considering the clarity of results we can conclude that, the foldscope are useful tool in microscopic examination studied furthermore, it is more required to asset e field of diagnosis of an infectious disease or to asses early diagnosis particularly in the in the rural and remote area. Our long-term vision is to universalize frugal science, using this platform to bring microscopy to the masses.

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