Zev Leifer, PhD, Professor of Pre-Clinical Sciences, presented a poster at the 4th Digital Pathology and Artificial Intelligence Congress, held in New York, on June 6-27, 2018.

http://www.global-engage.com/event/digital-pathology-usa/

The title of the poster is:

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The Foldscope (developed by Dr. Manu Prakash at Stanford U.), is a $1.00 paper microscope that works as well as a microscope costing $1,000 or much more, was studied to analyze its potential for use in urinalysis, especially in impoverished areas of the world. The major work was done by two of our students, Rebecca Calder and Daniel Stevens (both DPMs, members of Class of 2018).

Dr. Leifer said: “I am proud of their efforts, their intellectual contributions to the development of the project and their skill, based on their certification and experience as Lab Technicians. We can all be proud of them.”

See next page for poster
PRELIMINARY STUDIES IN THE USE OF THE FOLDSCOPE PAPER MICROSCOPE FOR DIAGNOSTIC ANALYSIS OF CRYSTALS IN URINE: ISSUES IN THE ANALYSIS OF LIQUID SAMPLES AND POTENTIAL APPLICATIONS IN LOW BUDGET/LOW TECH REGIONS OF THE WORLD

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Abstract

The Foldscope was developed by Dr. Manu Prakash at Stanford as a cheap (under $1.00) microscope made of paper and usable for microscopy by students all over the world and in more serious research or diagnostic roles by professionals. It is especially advantageous to those in regions of the world where budget and availability of high-end instrumentation is severely limited. Here at NYCPM, we obtained a Foldscope from Dr. Prakash. We assembled it (“Fold on the dotted lines”), inserted battery and lens and produced a microscope. Two of us (RC and DS) had prior certification and experience as laboratory technicans, including urinalysis. It was determined to evaluate if the Foldscope could be used in this role. Preliminary projects were designed to test this, by preparing samples of likely target crystals – uric acid and calcium oxalate. This was preliminary, as real urine samples from real patients required complex IRB approval, rules and regulations. In this study, it was determined that the crystals could in fact be visualized with this low budget instrument. Furthermore, several issues emerged, different from using a glass or digitized slide – e.g., holding the microscope up to a light source resulted in the liquid sample dripping on the observers face (1). Methods were developed to keep it flat, with attention to clamps to hold it and a light source appropriately placed. Successful imaging by iPad or cell phone allows the necessary component of Telepathology implicit in its application. Further development is needed as to methodology and as to validation with patient samples. Determination of the full range of identifiable crystals and cells of diagnostic significance would expand the usefulness of this application. Its use in low budget/low tech regions of the world would be greatly advantageous.

Observations

Preliminary

The Foldscope was adequate to the task of viewing glass Pathology Slides. Text slide: Healed Ghan tubercle, low power, high power. See Fig. 4A and 4B.

Experimental

Q 1) Can the Foldscope be used to identify relevant crystals in solution?
A 1) Yes, See Fig. 5B (calcium oxalate) and 6B (uric acid)

Q 2) Does the image obtained with the Foldscope compare favorably with that obtained by a traditional light microscope?
A 2) Yes, Compare Fig. 5A (Foldscope) with Fig. 5B (microscope) for calcium oxalate. Compare Fig. 6A (Foldscope) with Fig. 6B (microscope) for uric acid.

Q 3) What operational issues could be identified that affect the usability of the Foldscope in urinalysis?
A 3) Several issues emerged, highlighting differences compared to using a glass or digitized slide – e.g., holding the microscope up to a light source resulted in the liquid sample dripping on the observers face (1). This is not only relevant to "idk" and mess but also to the possible spread of infectious organisms or exposure to toxic molecules to skin, eyes or mouth. The methodology described here may be used to analyze other liquid samples, e.g, blood, with similar concerns.

Therefore:

Methods were developed to keep it flat, with attention to clamps to hold it and a light source appropriately placed.

In addition, methods were developed to take the images with iPad or cell phone. Images were stored use http://ips.com and were available to the group and, with id and password, to the world. Email, texting and the web site opens up the possibility of distance diagnosis.

Conclusion

The Foldscope can be used to find and identify crystals in solution. It compares well to the use of a far more expensive light microscope.

Discussion

“In New York,” so to speak, this might not be greatly needed. But there are regions of the world where instrumentation that costs $1 vs. $800 makes a big difference. In fact, this was the original observation that moved Dr. Prakash to develop the Foldscope. Even in the field, perhaps patients could be trained to use it to photograph their own samples and send them to the hospital to identify. If need be, the local lab could send it out (Telepathology) to a consultant with more experience to make the diagnosis.

Further work on this project would be to submit an IRB proposal to support a protocol to study actual urine samples to verify this work in a clinical setting.

Determination of the full range of identifiable crystals and cells of diagnostic significance would expand the usefulness of this application.

Methods & Materials

Obtained Foldscope and assembled it.

See Fig. 1A and 1B. The Unfolded Foldscope
See Fig. 2A and 2B. Folding Instructions
See Fig. 3A and 3B. The Folded Foldscope

Sample solutions of Uric acid and Calcium Oxalate in water were prepared.

References

1. Foldscope: Good overview: https://en.wikipedia.org/wiki/Foldscope

   “Types of crystals found in human urine and their clinical significance”

3. Diagnostics in Developing Countries: A good review
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4665590/

Introduction

Urinalysis

There are a large number of disease conditions that can be detected by an analysis of the crystals and other structures or organisms that can be found in a drop of urine. See Ref. 2.

Microscopy

Classically, this analysis is carried out in a certified diagnostic lab, wherein a trained technician prepares a sample of urine and places a drop on a glass slide and analyses it for diagnostically significant contents.

The Foldscope

The Foldscope was developed by Dr. Manu Prakash at Stanford as a cheap (under $1.00) microscope made of paper and reusable for microscopy by students all over the world and in more serious research or diagnostic roles by professionals. It is especially advantageous to those in regions of the world where budget and availability of high-end instrumentation is severely limited. See Ref. 3.

He developed the Foldscope and has been distributing it worldwide by the thousands to encourage its use in teaching and research and a general awareness of the microscopic world.

The project

We set out to determine if the Foldscope could be used as a low cost microscope capable of making the same level of diagnostic capacity as a (far more expensive) microscope. Along the way, a number of issues developed which may be helpful to share with those who may wish to use this system.

Three goals were defined: 1) Can the Foldscope be used to identify relevant crystals in solution? 2) Does the image obtained with the Foldscope compare favorably with that obtained by a traditional light microscope? 3) What operational issues could be identified that affect the usability of the Foldscope in urinalysis?