Histological features of kidney observed through conventional microscope and paper microscope

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ABSTRACT

Introduction: Paper microscope (Foldscope), one of the latest inventions in the field of science is an ultra-low cost, portable, versatile, and water proof microscope which does not require electricity. The aim of this research was to compare histological features of kidney observed in the normal microscope and foldscope. This research is focused on the comparison of the histological features of kidney observed in the conventional microscope and foldscope under 100X.

Method: This comparative study was conducted in Department of Anatomy, Nepalese Army Institute of Health Sciences, Nepal. All histological slides of kidneys present at Department of Anatomy during June 2019-September 2019 were included in this study.

Result: A total of 25 samples were viewed under the conventional laboratory microscope (C x L and Paper Microscope (Foldscope). Foldscope observers were able to distinguish the histological features of the cortex and the medulla of the kidney along with the difference in the luminal size and the staining of the cells in the cortex and the medulla of the kidney. In comparison to conventional microscope, 5 (20%) of samples, observers were able to distinguish the features of the cells lining the tubules of the cortex and in 6 (24%) of samples, observers were able to distinguish the features of the cell lining collecting duct and straight tubules of loop of Henle of medulla using Foldoscope.

Conclusion: Paper microscope can be a useful alternative of conventional microscope in low resource settings for the identification of the histological samples.

Keywords: foldscope, histology, microscope

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INTRODUCTION

Paper microscope (Foldscope), one of the latest inventions in the field of science is an ultra-low cost, portable, versatile, and water proof microscope which does not require electricity. This research is focused on the comparison of Paper Microscope (Foldscope) in the evaluation of the histological slides of kidney by comparing the histological features of kidney observed in the Foldscope with the conventional microscope under 100X. The results will enable us to know about the use of Foldscope in the field of histology for the identification of histological samples by appreciation of peculiar histological features. The aim of this research was to compare histological features of kidney observed in the normal microscope and foldscope and to explore the possibility of using paper microscope in the field of histology and to identify histological samples. This research is focused on the comparison of the histological features of kidney observed in the conventional microscope and paper microscope (Foldscope) under 100X.

METHOD

This observational comparative study was conducted in Department of Anatomy, Nepalese Army Institute of Health Sciences, Nepal. This study site was selected for convenience of the researcher. Histology slides of Kidneys were used as samples for this study, kidney was selected by lottery method before the start of the study. All histological slides of kidneys present at Department of Anatomy during the period of study were included in this study while slides with air bubbles, non-uniform staining, slides with overlapping structures, squeeze and prefixation artifacts were not included in this study.

This study was conducted from June 2019-September 2019. Samples of histology slides of the kidney were viewed under 100X in both the conventional microscope and the paper microscope (foldscope) and the comparison of the histological features were carried out. The histological features for identification of kidney used for the study were renal corpuscle that comprises of Bowman's capsule, Glomerulus, Urinary space, sections of proximal convoluted tubules (PCTs) and distal convoluted tubules (DCTs) in the cortex, sections of collecting ducts and straight tubules of loop of Henle in medulla. The tubules and ducts were further identified by their lumen, staining of cells and lining epithelium.

No ethical issues were identified in the study design, the study being vetted and approved by the Institutional Ethics Committee. In order to minimize the measurement errors, prior orientation and training to the data collectors were carried out. The observations were first observed by third year medical students, each slide was observed by two observers and again each slide was verified by a faculty member of department of Anatomy to eliminate the errors in observation. Intra-observer variation was not observed. Digital photographs of the observations were taken and shown in appropriate figures and tabular representation of the observations were done.

RESULT

A total of 25 samples were viewed under the conventional laboratory microscope (C x L binocular laboratory microscope and Paper Microscope (Foldscope). The following results were obtained:

Out of the total 25 slides observed through conventional microscope and foldscope, all distinctive histological features of kidneys were visible by both methods as shown in Table 1.

The tubules in the cortex were further observed for appreciation of lumen, staining of cells and cell lining the tubules. The observations of lumen and staining of cells were appreciated by both methods while the cell lining the tubules were visible only in 5 observations made through the foldscope as shown in Table 2.

The luminal size, staining of the cell and cell lining the collecting ducts and straight tubules of loop of Henle in the medulla was observed through both the microscope. In all samples the luminal characters and the staining of the cell was possible to appreciate through the paper microscope considering the conventional microscope as standard. But in only six (6) i.e. 24% of the sample the cell lining the collecting ducts and loop of Henle was appreciated in the medulla of the kidney considering the conventional microscope as standard as shown in table 3

Table 1. Table showing Observations of cortico-medullary distinction

Observations	No of observations appreciated in conventional microscope	No of observations appreciated in paper microscope (Foldscope)
Bowman's Capsule of renal corpuscle in cortex	25	25
Glomerulus of renal corpuscle in cortex	25	25
Urinary space in cortex	25	25
Section of PCTs and DCTs in cortex	25	25
Section of collecting duct and straight tubules of loop of Henle in medulla	25	25
Total no of observations	25	25

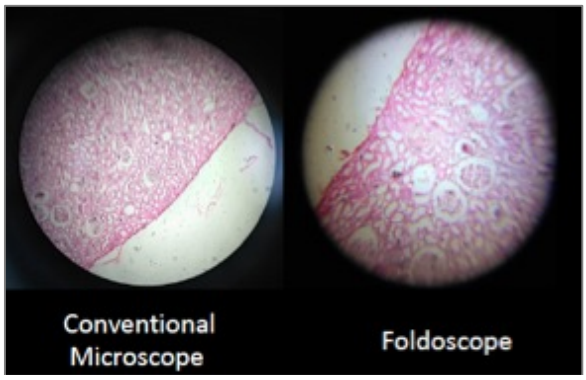

Figure 1. Photographs of histological features of kidneys observed through conventional microscope and foldscope

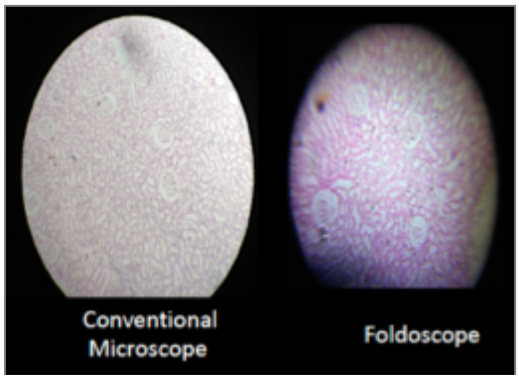

Figure 2. Histological Features of cortex of kidneys using conventional microscope and foldscope

Table 2. Observations of PCTs and DCTs in the cortex by conventional microscope and foldscope

Observation	No of observations appreciated in conventional microscope	No of observations appreciated in paper microscope (Foldscope)
Lumen	25	25
Staining of cells	25	25
Lining epithelium of tubules	25	5

Table 3. Observations of tubules in the medulla by conventional microscope and foldscope

Observation	No of observations appreciated in conventional microscope	No of observations appreciated in paper microscope (Foldscope)
Lumen of collecting duct and straight tubules of loop of Henle	25	25
Staining of cells	25	25
Lining epithelium of collecting duct and loop of Henle	25	6

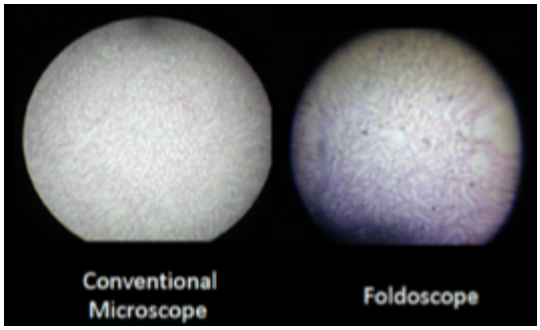

Figure 3. Histological features of cortex of kidneys using conventional microscope and foldscope

However, the quality of pictures taken through the conventional microscopes were more sharp, clear with well-defined margins.

DISCUSSION

Foldscope is made by folding paper in the origami fashion (Japanese art of paper folding) by assembling the different parts with 100X magnification lens. Traditional microscopes are heavy, bulky, expensive and require electricity but this microscope weigh less than 20 gram and can easily fit in the pocket enabling us to carry the microscopic observation anywhere, anytime, and can be helpful in the identification of histological slides. The Foldscope can be assembled from a flat sheet of paper in under ten minutes.

Although foldscopes cost less than a dollar, it can provide over 2,000 times magnification with submicron resolution, weighs less than two nickels

(8.8 g), is small enough to fit in a pocket (7062062 mm3), requires no external power, and can survive being dropped from a 3-story building or stepped on by a person. Its minimalistic, scalable design is inherently application-specific instead of general-purpose, providing less functionality at dramatically reduced cost. Unlike traditional microscopes, the Foldscope anchors the sample at a fixed location while the optics and illumination stages are moved in sync.[1]By removing cost barriers, Foldscope provides new opportunities for a vast user base in both science education and field work for science and medicine. A universal program providing ''a microscope for every child'' could foster deep interest in science at an early age. While people have known for decades that hands-on examination and inquiry is crucial in STEM (Science, Technology, Engineering, and Mathematics) education.[2-3] Disease-specific Foldscope designs are an important vision for future development.[4-5] Foldscope can be reversibly coupled to a conventional smartphone for image capture, for smartphone-based diagnostics, or for telemedicine.[5-9]

In all the samples observed through paper microscope the observers were able to distinguish the histological features of the cortex and the medulla of the kidney along with the difference in the luminal size and the staining of the cells in the cortex and the medulla of the kidney. But only in 20% of samples the observers were able to distinguish the features of the lining epithelium of the cortex. And in only 24% of the samples observers were able to distinguish the features of the lining epithelium of the medulla whereas in the conventional microscope the observers were able to appreciate the characters of the lining epithelium in the medulla and cortex in all samples.

Nikita et al conducted a similar study to evaluate the diagnostic utility of foldoscope against conventional bright field microscopy in patients with lower respiratory tract and fungal infection in which the data visibility for wet mount stains were somehow similar to light microscopy while data visibility for Gram staining and Zeihl-Neilson staining was poor using foldoscope.[10] In our study, the data visibility was better. A similar study had found that foldosocpe has a sensitivity of 55.9%.[11]

Data visibilty and clarity of the image formed by paper microscope was not good as that formed by the conventional microscope. Distortion of the image along with blurred areas in the periphery was noted with small central area of good image. Even though both the conventional and the paper microscope was kept in 100X magnification the image formed by the paper microscope was found to have greater magnification than that of the conventional one.

Limitation of the study

The study is limited to study of histological slides of kidney only.

CONCLUSION

The results suggest us that paper microscope is able to distinguish the histological features of the kidney. Considering the result obtained, price, versatile nature and the operating cost of the paper microscope it can be used in the field of histology for the identification of the histological features if the samples. The paper microscope can be a useful alternative of conventional microscope in low resource settings for the identification of the histological samples.

Conflicts of Interest

None

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