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FOLDOSCOPE : SCOPE IN NEUROSURGERY
A FEASIBILITY STUDY

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INTRODUCTION

• Microscopes are ubiquitous tools in science, providing an essential, visual connection between the familiar macro-world and the remarkable underlying micro-world and the field has evolved to provide numerous imaging modalities with resolution approaching 250 nm and smaller.

• Conventional microscope is commonly used for CNS histopathological evaluation and trained pathologist is required for the evaluation of the slide.

• In emergency situations and in rural areas it is not always possible to access for microscope and pathologist for histopathological investigations due to resource limitation.

• Mobile phone-based microscopy could be one solution to overcome this health sector limitation.

• The foldoscope is an paper microscope inspired by origami. It costs less than a dollar. It can provide over 2,000× magnification with submicron resolution. Weighs less than two nickels (8.8 g), Small enough to fit in a pocket (70×20×2mm³), Requires no external power.
DISCLOSURES:

• NO CONFLICT OF INTEREST.
• NO EXTERNAL SOURCE OF FUNDING.
AIM AND OBJECTIVE OF THE STUDY

• To Compare the images of Squash cytology under the mobile phone-based microscopy and conventional microscopy.
• To study the extent of foldoscope use in studying squash slide and study its limitations.
• To find the feasibility of using mobile phone-based microscopy images in rural and emergency set up.
MATERIAL AND METHODS

• Study design:
  • Total 15 Cases From Month Of March, 2019 To September, 2019 Were Included In The Study.

• Sample preparation:
  • A smear slide was prepared by taking 1-2 millimeters (mm) of the biopsy material with the scalpel blade.
  • Placing the material on a slide and crushing with another slide with just enough pressure to spread the tissue into a thin film in the operation theatre.
  • It was then fixed in 95% alcohol and stained by Hematoxylin and Eosin (H & E).
  • Relevant clinical and radiological data were noted.

• Methodology:
  • Raw foldoscope paper was open and assembled in order to conduct this study.
  • After assembly, each histology slides were being imaged through Foldoscope and mobile phone. Then the same slides also being imaged in conventional microscope as reference image.
MATERIAL AND METHODS

FOLDOSCOPE AFTER ASSEMBLY
FOLDOSCOPE ATTACHED TO CELL PHONE WITH MAGNETIC COUPLER
EXTERNAL ILLUMINATOR ATTACHED TO FOLDOSCOPE
GLASS SLIDES, EOSIN&HEMATOXYLIN STAIN
CONVENTIONAL MICROSCOPE
EPIDERMOID (ACELLULAR MATRIX)

HIGH GRADE GLIOMA (HYPERCELLULARITY AND PLEOMORPHISM)

LOW GRADE GLIOMA (FIBRILLAR MATRIX WITH GLIAL CELLS)

PITUTARY MACROADENOMA (UNIFORM ROUND LOOKING NUCLEUS, NO PLEOMORPHISM)
RESULTS

COMPARING PROCESSING TIME OF SQUASH SLIDE IN VARIOUS SCENARIOS

TISSUE IN OT

- SQUASH IN OT BY FOLDOSCOPE
  1. WITH IN 15 MIN.
  2. REPEAT SAMPLE CAN BE DONE IMMEDIATELY.

- SQUASH IN GROUND FLOOR IN SAME HOSPITAL BY CONVENTIONAL MICROSCOPE
  1. WITH IN 30-35 MIN

- SQUASH DONE IN OUTSIDE HOSPITAL (>500M) BY CONVENTIONAL MICROSCOPE
  1. MORE THAN 1HR
  2. CHANCE OF SAMPLE MISPLACE

COMPARING SQUASH IMAGE ACQUIRED DIAGNOSIS BY VARIOUS PATHOLOGISTS

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Pathologist 1. (3yrs experience)</th>
<th>Pathologist 2. (3yrs experience)</th>
<th>Pathologist 3. (8yrs experience)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBM (4 cases)</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>LOW GRADE GLIOMA (3 cases)</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>CEREBELLAR HEMANGIOBLASTOMA. (1 case)</td>
<td>−</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>MENINGIOMA (4 cases)</td>
<td>−</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>EPIDERMOID (1 case)</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>PITUTARY ADENOMA</td>
<td>+</td>
<td>+</td>
<td></td>
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</tbody>
</table>
### COMPARING THE NO OF TUMOURS IDENTIFIED BY FOLDOSCOPE ON SQUASH SLIDES WITH CONVENTIONAL MICROSCOPE:

<table>
<thead>
<tr>
<th>No of tumours</th>
<th>foldoscope</th>
<th>Conventional microscope</th>
<th>Not able to identify</th>
</tr>
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<tbody>
<tr>
<td>15</td>
<td>10</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>

### COMPARISON BETWEEN FOLDOSCOPE AND CONVENTIONAL MICROSCOPE:

<table>
<thead>
<tr>
<th></th>
<th>CONVENTIONAL MICROSCOPE</th>
<th>FOLDOSCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRICE</td>
<td>15000 TO 20000 rs</td>
<td>50rs(1$)</td>
</tr>
<tr>
<td>ILLUMINATION</td>
<td>EXTERNAL POWER SOURCE REQUIRED</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
<td>MAINTAINANCE</td>
<td>REQUIRED</td>
<td>NILL</td>
</tr>
<tr>
<td>MAGNIFICATION</td>
<td>100X, 400X, 1000X</td>
<td>140X</td>
</tr>
<tr>
<td>PANNINGING OF SLIDE</td>
<td>GOOD</td>
<td>LITTLE DIFFICULT</td>
</tr>
</tbody>
</table>
SUMMARY

• Conclusions:
  • Squash Cytology by Foldoscope has sensitivity of 66.6% and specificity of 33.4%.
  • Reduce the transport time of the sample and gives immediate report.
  • Repeat sample can be done.
  • Pathologist with more experience with squash cytology has more positive results.

• Limitations:
  • Focusing On The Slide is Only at the Center of the Area compared to adjacent areas.
  • 140x lens Only Available with the device.
  • Millimeter defect In The Assembly leads to Failure Of The Device.
  • Poor Knowledge Of Squash Slide Preparation And Squash Cytology.

• Further Studies:
  • With Its Clear Limitations, Improvements Can Be Made To Transform It Into A Cost-effective Use Device Exclusive In The Diagnosis Of Cancer In Remote And Emergency Situation