

Background

Digital pathology has been increasingly gaining the attention of pathologists worldwide. However, the application of digital cytology by Panoptiq™ is relatively unexplored. The microscope-based scanning software, Panoptiq™, enables the operator to combine low-power panoramic digital images with z-stacks at regions of interest with a significantly smaller image size than that obtained by whole slide scanning. This study aimed to evaluate the feasibility of the use of Panoptiq™ in the digital interpretation of cervicovaginal cytology specimens in comparison with the conventional light microscope.

Methods

One hundred SurePath™ liquid-based cytology slides were selected sequentially. The dotted slides were reviewed and scanned where all dotted areas were further scanned by the 20x objective with z-stacks. The cases were reviewed by four pathologists and a cytotechnologist using conventional light microscopy and digital cytology images acquired by Panoptiq™ and interpreted based on Bethesda classification system. The washout time was set as three weeks. The Cohen's kappa coefficient was calculated to measure the agreement between the two modalities.

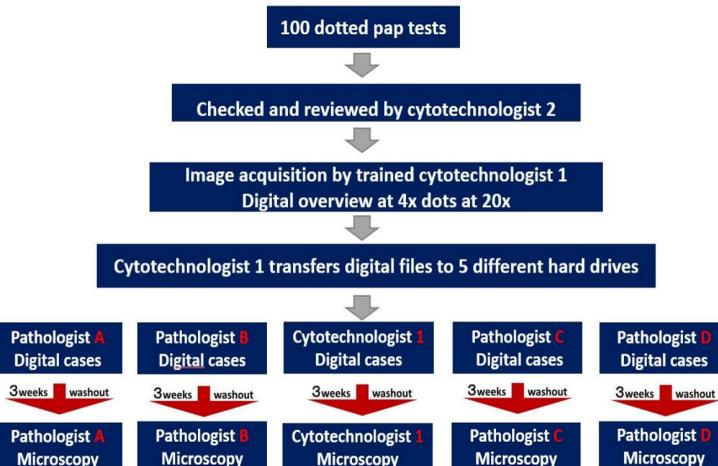


Figure 1: Methodology flowchart: data acquisition and observers.

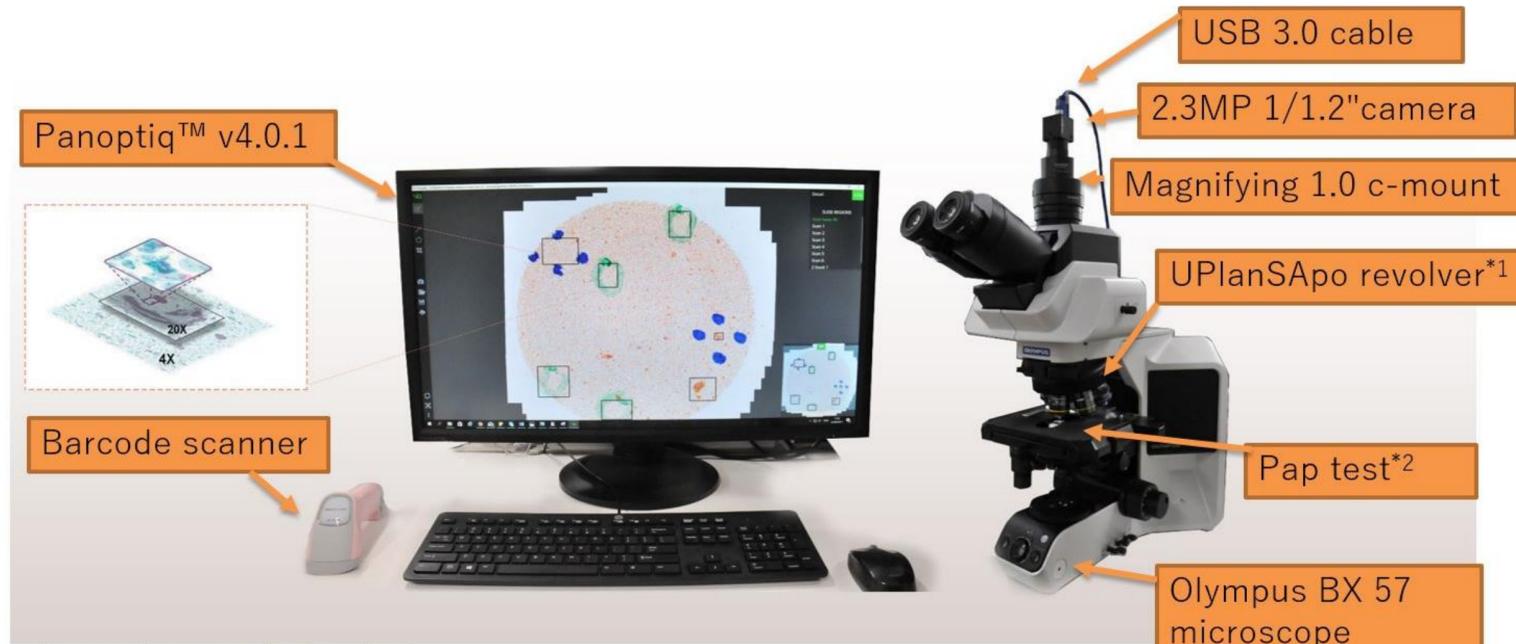
Digital cytology cases analysis

- Four out of 100 cases contained corrupted data caused by z-stacks that were not fully embedded on the main scan, this issue was fixed subsequently in the next software version.
- The average data size was 226 megabytes/slide (range: 64.4 - 483.4)
- The average image scanning time was 4.36 minutes/slide (range: 3:11 - 7:03)

Table 1: Concordance Rate and Kappa Statistics for Inter-Modality Agreement (n = 96)

Observer	Concordance rate% (n)	Kappa value	Confidence interval
Pathologist A	88.5% (85)	0.84	0.75 – 0.93
Pathologist B	56.3% (54)	0.41	0.27 – 0.53
Pathologist C	81.2% (78)	0.76	0.66 – 0.86
Pathologist D	57.3% (55)	0.44	0.32 – 0.56
Cytotechnologist	89.6% (86)	0.86	0.78 – 0.94

Figure 2: A Blackfly® digital camera (model BFLY-U3-23S6C) was mounted on an Olympus U-TV1XC c-mount. This set was then attached on top of an Olympus BX57 microscope with an UPlanSApo revolver holding the 4x (0.16), 10x (0.4), 20x (0.75), and 40x (0.95) objectives (numerical aperture).



*1Numerical aperture: 4x (0.16), 20x (0.75)

*2Liquid-based cytology preparations

Results

Table 2: Concordance Rate and Kappa Statistics for Inter-observer Agreement using Panoptiq™ imaging system (n = 96)

	Pathologist B	Pathologist C	Pathologist D	Cytotechnologist
Pathologist A	0.37 (0.25 – 0.50)	0.22 (0.11 – 0.33)	0.22 (0.12 – 0.33)	0.52 (0.39 – 0.65)
Pathologist B	-	0.27 (0.15 – 0.38)	0.31 (0.19 – 0.43)	0.72 (0.61 – 0.82)
Pathologist C	-	-	0.44 (0.32 – 0.56)	0.31 (0.19 – 0.43)
Pathologist D	-	-	-	0.34 (0.22 – 0.47)

Table 3: Concordance Rate and Kappa Statistics for Inter-observer Agreement using Conventional Light Microscopy (n = 100)

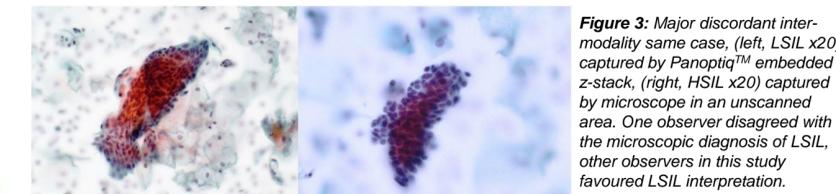
	Pathologist B	Pathologist C	Pathologist D	Cytotechnologist
Pathologist A	0.24 (0.10 – 0.37)	0.26 (0.15 – 0.38)	0.17 (0.06 – 0.28)	0.38 (0.26 – 0.50)
Pathologist B	-	0.28 (0.17 – 0.39)	0.29 (0.18 – 0.41)	0.41 (0.29 – 0.54)
Pathologist C	-	-	0.41 (0.29 – 0.53)	0.27 (0.15 – 0.39)
Pathologist D	-	-	-	0.18 (0.05 – 0.31)

Table 4: Overview of Discrepant Inter-Modality Diagnosis Rendered by Pathologist B

Judgment by Conventional Light Microscopy		Judgment by Panoptiq™							Total
		NILM	ASC-US	ASC-H	LSIL	HSIL	SCC	AC	
NILM	0	0	0	0	0	0	0	0	0
ASC-US	5	11	0	5	0	0	0	0	21
ASC-H	0	1	3	3	0	0	0	0	7
LSIL	0	11	2	24	1	0	0	0	38
HSIL	0	0	5	7	14	0	1	0	27
SCC	0	0	0	0	1	0	0	0	1
AC	0	0	0	0	0	0	2	0	2
Total	5	23	10	39	16	0	3	0	96

Discussion

- Experience in digital readings matters for inter-modality variation
- Analysis of discrepant cases, seven inter-modality discordant cases of pathologist B were extracted 6 out of 7 were not discordant by group consensus
- Opportunities for digital cytology in developing countries



Conclusion

- We showed that cervical cytology can be manually scanned under 5 minutes with an average data size not exceeding 500 megabytes/slide and can therefore be easily used as an alternative to whole slide images for low-throughput laboratories.
- The cytotechnologist needs to be well aware of the method of image acquisition which could induce a selection bias also observer experience in digital modalities is a risk factor, as the lack of it could lead to an erroneous outcome.

References

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2. Goswami R, Pi D, Pal J, Cheng K, Hudoba De Bady M. Performance evaluation of a dynamic telepathology system (Panoptiq™) in the morphologic assessment of peripheral blood film abnormalities. *Int J Lab Hematol.* 2015;37:365-371.
3. Hanna MG, Monaco SE, Cuda J, Xing J, Ahmed I, Pantanowitz L. Comparison of glass slides and various digital-slide modalities for cytopathology screening and interpretation May 30, 2017. *Cancer Cytopathol.* doi: 10.1002/cncy.21880.