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The experience of introducing telepathology in Mongolia

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ABSTRACT

Background: Anatomical pathology care services play an essential role in cancer diagnosis through histological analysis, effective treatment of patients, and determination of prognosis. Therefore, quality control is necessary for the diagnosis of pathology. Based on this need, telepathology technology is rapidly developing in the world. This study aimed to share the experience of implementing telepathology case consultation between Mongolian and Japanese expert pathologists.

Methods: The study included 173 cases that required telepathology consultation, which was complicated and doubtful in diagnosis, submitted by Mongolian pathologists between May 2019 and April 2022. The scanned digital slides were transmitted with the help of the LOOKREC cloud-based system, and the expert pathologists of Hiroshima University Hospital, Japan, browsed the images through the data on the internet and their advice and made a mutual diagnosis.

Results: During the study period, 173 cases were consulted. Out of 58.4% of all cases, consultation reports were released in 2022. The majority of the cases in 2020 had a mean standard deviation turn-around time of 4.2 ± 6.2 days. The most cases were from the lung and mediastinum were 29.4%, followed by head and neck at 12.6%, the bone at 11.9%, lymph nodes at 8.4%, GIT at 7.7%, soft tissues at 6.3%, etc. Comparing the sample submission of biopsy and cytology was significantly higher in the under 10 years of an experienced group than over 10 years of an experienced group ($p<.005$). The diagnostic agreement between submitter Mongolian pathologists and expert Japanese pathologists was 82.7%, and disagreement was 17.3% of all cases, with a sensitivity of 67.3% and specificity of 85.5%.

Conclusions: Telepathology could save many lost opportunities and play an essential role in developing quality control and surgical pathology in Mongolia. This digital technology and the appropriate strategy and policy of the government could accelerate the overall pathology field development.

Introduction

In Mongolia, the history of anatomical pathology science has been developing since 1933.[1] Anatomical pathology care services play an essential role in diagnosing cancer through histological analysis, effective treatment of patients, and determination of prognosis. Not only is there a limited supply of trained and experienced pathologists throughout Mongolia, but most are working in large hospitals in the capital, which is a challenge to provide uniform access to pathology services. Errors in pathological diagnosis are not uncommon, but each diagnosis is a vital profession that requires the highest level of responsibility. Therefore, quality control is necessary for the diagnosis of pathology. Based on this need, telepathology technology is rapidly developing in the world.

Telepathology is a technology of practical significance in pathology where pathologists digitize patient tissue and cell analysis slides using whole slide imaging (WSI) technology to consult with each other and make diagnoses regardless of space. This technology is being used in many areas of pathology practice, including remote consultation, quality control, training, and continuing medical education.[2,3] However, some challenges have arisen that are related to the use of virtual slides in cytology compared with relatively uniform 3–5 μm thickness histology slides. First, most cytological diagnoses require high magnification, which allows

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greater detail for nuclear evaluation. Second, the thick smears or 3-dimensional (3D) cell groups of cytology slides are difficult to focus on. Since nuclear morphology is an important parameter in cytopathology, some WSI technology provides advanced capabilities of visualizing 3D structures in diagnostic cytopathology with the help of the "Z stack" function, which can produce the required depth of focus at predefined intervals.[4–6]

This digital technology can offer many advantages, including annotations for training programs, screening processes, archiving, sharing slides, and case consultation remotely. However, some studies are concerned with prolonged diagnostic time in routine work due to its functional operation on the system.[6,7] However, telepathology provides an opportunity to solve the shortage of pathologists and medical specialists in remote areas and properly use limited specialist resources.[8]

To improve the quality of pathology analysis and diagnosis, the National Center of Pathology, Mongolia, installed the "NanoZoomer-SQ distance diagnosis" technology and equipment and successfully implemented telepathology technology between 2018 and 2021 with the funding of JICA—Japan International Cooperation Organization. This event allows local, metropolitan, and district pathologists to connect with Japanese pathologists online regardless of space and time to clarify and discuss pathology diagnoses, confirm diagnoses, detect diseases early, and treat clients.[5,9] To date, a study has yet to be written on the experience of implementing the application of telepathology on a daily basis in Mongolia. Our study aimed to share the experience of the implementation of telepathology case consultation between Mongolian pathologists and Japanese expert pathologists.

Materials and methods

Site and pathologists

The National Center for Pathology (NCP) is a state-centralized histological reference laboratory in Ulaanbaatar, Mongolia. The center is the first facility equipped with telepathology technics and technology in Mongolia and promoted to improve pathological diagnosis nationwide. The NCP established a telepathology remote diagnostic consultation center in January 2019. About 60 pathologists work all over the country of Mongolia. Twenty-two (22) from 9 different facilities participated in the NCP telepathology diagnostic consultation.

Telepathology diagnostic operation

The study included a total of 173 cases that required telepathology consultation, which was complicated and doubtful in diagnosis, submitted by Mongolian pathologists between May 2019 and April 2022. First, the pathologists examined all specimens and processed them in the laboratory. Then, the telepathology technician scanned the slides requested by the pathologists and converted them into whole-slide images (WSIs) using Nanozoomer SQ (Hamamatsu Photonics, Hamamatsu City, Japan) remote diagnostic equipment. The digital slides were transmitted with the help of the LOOKREC cloud-based system (MNES Inc.), and the expert pathologists of Hiroshima University Hospital, Japan browsed the images through the data on the internet and their advice and made a mutual diagnosis. For a detailed procedure of telepathology consultation, the submitter Mongolian pathologists request diagnostic consultation by attaching the WSI of a slide and relative clinical information. Next, the technician checks and completes the submission of images to the system and expert pathologist—the system manager contacts and emails the expert pathologists about the submitted slides. Then, the expert pathologists log into the website, check and review the pending case, and submit back the final report of diagnosis to the system. Once the expert pathologist releases the final report, they inform their technician, who sends final reports to the submitter pathologists by email or internal system.

Table 1
TAT comparison between cases in 2019 and 2022.

Year	Case number (%)	TAT (Days)			
		Minimum	Maximum	Mean	Std. deviation
2019	28 (16.2)	3	68	15.5	19.4
2020	101 (58.4)	0	29	4.2	6.2
2021	39 (22.5)	0	65	6.6	13.8
2022	5 (2.9)	0	1	0.6	0.5
Total	173 (100)	0	68	6.5	11.9

Statistical analysis

Data processing was performed using Microsoft Excel 2016 and SPSS 22.0.

Results

During the study, 173 cases were consulted between a submitter group of Mongolian pathologists and an expert group of Japanese pathologists. There were 28 cases in 2019, 101 in 2020, 39 in 2021, and 5 in 2022. Table 1 shows the turn-around time (TAT) for pathology consultation in 2019–2022. Out of 58.4% of all cases, consultation reports were released in 2022, and 22.5%, 16.2%, and 2.9% had a consultation in 2021, 2019, and 2022. The average of total cases mean of turn-around time was 6.5 ± 11.9 days. Most of the cases in 2020 had a mean TAT of 4.2 ± 6.2 days, while cases in 2019 had a longer TAT of 15.5 ± 19.4 days (See Table 2).

This study included and discussed remotely a total of 143 cases of histology and 30 cases of cytology during the study period (Table 1). In all histological cases, most cases from the lung and mediastinum were 29.4%, followed by head and neck at 12.6%, the bone at 11.9%, lymph nodes at 8.4%, GIT at 7.7%, and soft tissues at 6.3%, etc. The most significant proportion of cytology samples was pleural effusion at 76.7%, followed by ascites at 13.3%, urine, cerebrospinal fluid, and pericardial effusion in both at 3.3%, respectively.

Based on the submitter, Mongolian pathologists' experience was divided into 2 groups: under 10 years (n = 12) and over 10 years (n = 10). In this study, pathologists with up to 10 years of experience had significantly higher rates of case consultation on biopsy and cytology samples than pathologists with over 10 years of experience ($p < .005$) (Table 3). Furthermore, the pathologist's submission interest was more in the under 10 years of experience group than the over 10 years of experience group in 2019, 2021, and 2022. However, the senior Mongolian pathologists were more active in 2020. The diagnostic agreement rate was higher in senior Mongolian pathologists than in junior Mongolian pathologists, 73.3% and 63.3%. Biopsy submission was varied in 2 groups, including 88 cases by pathologists with under 10 years of experience and 55 cases by pathologists with over 10 years of experience. Biopsy consultation requests were dominantly lung (31.8% and 25.5%) in both experienced groups. However, head and neck (14.8%) and bone (12.5%) were the following consultation case in less-experienced pathologists. In comparison, a more-experienced group of pathologists had consultation requests for samples from the gastrointestinal tract (14.5%), bone (10.9%), and lymph nodes (10.9%). Cytology requests were similar between under and over 10 years of experienced pathologists groups.

The diagnostic agreement between submitter Mongolian pathologists and expert Japanese pathologists is shown in Fig. 1. Expert consultants agreed with preliminary diagnosis in 82.7% of total cases, including biopsy 65.7% and cytology 76.7% but disagreed with 17.3% of all cases, including biopsy 34.3%, and cytology 23.3%.

All 173 confirmed cases had a corresponding diagnosis with a sensitivity of 67.3%, and specificity of 85.5%. A detailed description of true-negative, true-positive, false-positive, and false-negative cases from the consultation is outlined in Table 4. Among the cases, the positive-predictive value (PPV) was 87.5%, negative-predictive value (NPV) was 63.4%.

Table 2
Distribution of cases and TAT from different sample subspeciality and organ systems.

Organ systems	Case number	Percentage	TAT (Mean ± SD)
Histological subspeciality			
Lung and mediastinum	42	29.4	6.4 ± 7.5
Head and neck	18	12.6	9.5 ± 19
Bone	17	11.9	5.2 ± 6.7
Lymph nodes	12	8.4	4.6 ± 5.3
GIT	11	7.7	3.1 ± 8.0
Soft tissue	9	6.3	1.4 ± 1.8
Bone marrow	6	4.2	1.8 ± 2.6
Skin	6	4.2	4.6 ± 7.3
US and MGO	5	3.5	2.4 ± 2.8
Gynecology	5	3.5	0.8 ± 0.8
Thyroid	4	2.8	1.0 ± 2.0
HBP	3	2.1	5.0 ± 7.8
Brain	3	2.1	10.6 ± 15.1
Breast	1	0.7	3.1
Total	143	100	
Cytological subspeciality			
Pleural effusion	23	76.7	10.4 ± 14.7
Ascites	4	13.3	33.25 ± 35.7
Urine	1	3.3	3
CSF	1	3.3	0
Pericardial effusion	1	3.3	1
Total	**30**	**100**	

Abbreviations: GIT, Gastrointestinal tract; U.S. and MGO, Urinary system and Male Genital Organs; HBP, Hepatobiliary, and Pancreas; CSF, Cerebrospinal fluid

Table 3
Factors associated with the two groups of pathologists' experiences.

Factors	Total n (%)	Submitter pathologists experience		*P*-value
		Under 10 years (n = 12)	Over 10 years (n = 10)	
		n (%)	n (%)	
Sample type				
Biopsy	143 (82.7)	88 (89.8)	55 (73.3)	<.005
Cytology	30 (17.3)	10 (10.2)	7 (26.7)	
Years				
2019	20 (16.2)	18 (18.4)	10 (13.3)	<.05
2020	101 (58.4)	48 (49.0)	53 (70.7)	
2021	39 (22.5)	28 (28.6)	11 (14.7)	
2022	5 (2.9)	4 (4.1)	1 (1.3)	
Agreement				
Yes	117 (67.6)	62 (63.3)	55 (73.3)	.161
No	56 (32.4)	36 (36.7)	20 (26.7)	
Biopsy consultation				
Lung	42 (29.4)	28 (31.8)	14 (25.5)	.054
Head and Neck	18 (12.6)	13 (14.8)	5 (9.1)	
U.S. and MGO	5 (3.5)	2 (2.3)	3 (5.5)	
Soft Tissue	9 (6.3)	7 (8.0)	2 (3.6)	
Bone	17 (11.9)	11 (12.5)	6 (10.9)	
Bone marrow	6 (4.2)	5 (5.7)	1 (1.8)	
GIT	11 (7.7)	3 (3.4)	8 (14.5)	
GYN	5 (3.5)	2 (2.3)	3 (5.5)	
HBP	3 (2.1)	3 (3.4)	0 (0.0)	
Skin	6 (4.2)	5 (5.7)	1 (1.8)	
Thyroid	4 (2.8)	1 (1.1)	3 (5.5)	
Breast	1 (0.7)	1 (1.1)	0 (0.0)	
Brain	3 (2.1)	0 (0.0)	3 (5.5)	
Lymph nodes	13 (9.1)	7 (8.0)	6 (10.9)	
Cytology consultation				
Pleural effusion	23 (76.7)	9 (90.0)	14 (70.0)	.741
Ascites	4 (13.3)	1 (10.0)	3 (15.0)	
Urine	1 (3.3)	0 (0.0)	1 (5.0)	
CSF	1 (3.3)	0 (0.0)	1 (5.0)	
Pericardial effusion	1 (3.3)	0 (0.0)	1 (5.0)	

Abbreviations: U.S. and MGO, Urinary system and Male Genital Organs; GIT, Gastrointestinal tract; GYN, Gynecology; HBP, Hepatobiliary, and Pancreas; CSF, Cerebrospinal fluid.

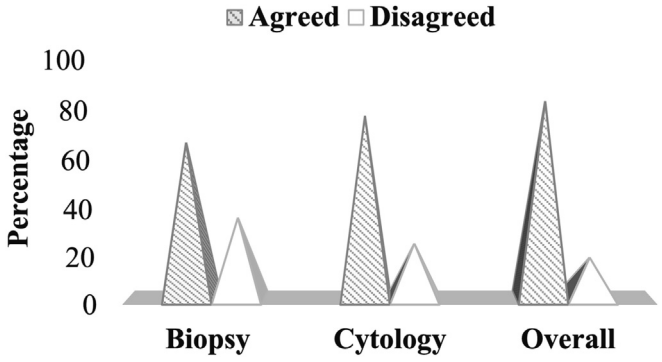

Fig. 1. Agreement rates of pathological diagnosis between experts and submitting pathologists

Discussion

Last decade, telepathology was successfully applied to routine diagnostic services in many countries.[2,10] In 2019, The Ministry of Health in Mongolia released an announcement to promote telepathology for diagnostic challenges in Mongolia and built a telepathology consultation network in the National Center for Pathology, Mongolia. The project was supported by the funding of "JICA" the Japan International Cooperation Agency, "The project for improvement of diagnostic ability in the Early phase of pneumoconiosis and asbestos-exposure-related respiratory diseases" was successfully implemented between 2018 and 2020. However, the duration has been extended to 2021 due to the COVID-19 pandemic. To date, there has yet to be a study written on the experience of implementing the application of telepathology on a daily basis in Mongolia. Our study aimed to analyze the situation of consulting medical specialists in advanced countries in pathological histology analysis with the help of telepathology technology.

The results of 3.5 years of experience and implementation of telepathology in Mongolia showed that the number of consultation cases was relatively stable each year. The second year of the implementation was the peak of the consultation cases, while the first and the last years were low in case numbers. Settling equipment of telepathology and program handling was the reason for the lack of case consultation in 2019. Most of the cases were diagnostic challenging lung disease cases due to the objective of the project implemented during the study project.

Analysis of the turn-around time of telepathology consultation showed that most of our consultation reports were released within 1 day (49%) for biopsy and 3 days (40%) for cytology. A previous study[11] reported that the average turn-around time was 7 days, similar to our study. However, most cases in our study had an average turn-around time of 4.2 days, a relatively shorter consultation duration. Given turn-around time, shorter time significantly impacts final diagnosis and patient treatment, and young pathologists primarily work in remote areas in Mongolia. The reason for the different TAT in our study is explained by the overloading of the cases from the total 22 submitter pathologists. However, it was difficult for the few expert pathologists to reply quickly. Therefore, in our case, the pathologist did not submit the cases as their own but did it by the special technical assistant. After the technician checks and completes the submission of images to the system and expert pathologist—the system manager contacts and emails the expert pathologists about the submitted slides. All those steps possibly affect the longer TAT in our study.

Due to the differences in sample types in biopsy and cytology, the distribution of consultation among different organs and systems may differ. Our results showed that lung, head and neck, bone, and lymph node cases accounted for the most significant proportion. In contrast, pleural effusion and urine cytology cases were dominant in telepathology consultation. Unlike in the study from China,[12] gastrointestinal, gynecology, head and neck, bone and soft tissue, and cases from the respiratory system were common to have telepathology consultation. In contrast, the Western study requested skin pathology and hematopathology cases.[13] This teleconsultation

Table 4
Concordance of consultation case diagnosis between expert and submitter.

Submitter's diagnosis	Expert's diagnosis			
	Positive		Negative	
	n	%	n	%
Positive	70	87.5	10	36.6
Negative	34	12.5	59	63.4
Total	104	100	69	100

difference may indicate the training needs of subspecialty pathologists and cytopathologists in Mongolia.

Based on the experience of pathologists, the number and type of consultation cases varied in our study. The case submission rate was higher, but the diagnostic agreement was lower in pathologists under 10 years of experience. Biopsy consultation requests were dominantly lung due to the project's objective but followed by the head and neck, bone, and soft tissue in pathologists under 10 years of experience, while the gastrointestinal tract, bone, and lymph nodes in pathologists with over 10 years of experiences. The reason may be that the hospitals have more surgical specimens from such body parts. Another reason is that the appropriate training for those case diagnosing needs to be included. Moreover, the majority of the participating pathologists are from urban areas. This may suggest that this study is more based on those urban pathologists who were more informed about telepathology, but diagnostic limitations and challenges have yet to be noticed in those participants from rural areas.

Multi-expert consultation or pathology consultation is a significant impact on final pathological diagnosis.[14] The diagnostic agreement between submitter Mongolian pathologists and expert Japanese pathologists was 82.7%, but the disagreement was 17.3% of all cases, with a sensitivity of 67.3% and specificity of 85.5% in our study. The difference was described by their initial and final diagnosis of both malignant and benign diseases. In developed countries,[15–17] the disagreement rate of pathology accounts for under 10%–14.2%; however, this rate is around 16%–64.3% in some developing countries.[12,18,19] Our result is higher than developed countries but in a range or lower than some Asian developing countries. This result suggests that telepathology is essential in quality control and assurance in pathology diagnosis.

The present study has a few limitations must indicate. Overall, cases were initially focused on the project's objective, which led to a selection bias in telepathology consultation cases. Therefore, most cases were submitted by pathologists at the National Center for Pathology, Mongolia, but only a few were from pathologists from rural areas. Despite this limitation, this study represents a novel research area in digital pathology technology because we attempted to identify the experience of telepathology for cancer diagnosis and quality control in Mongolia.

In addition, there is a notable shortage of pathologists in Mongolia's urban and rural areas, making surgical pathology challenging to develop in hospitals. Therefore, only a few well-experienced senior pathologists advise case consultation for less-experienced pathologists, which is almost impossible for rural area hospitals. This is another limitation of professional development for a few pathologists in remote areas. For pathologists from rural hospitals with challenging cases to come across the whole country to bring their slides for senior pathologists' consultation, which leads to the loss of a significant amount of time, money, and opportunity.

Conclusion

This telepathology could save many lost opportunities and play an essential role in developing quality control and surgical pathology in Mongolia. This digital technology and appropriate strategy and policy of the government in the near future could accelerate the overall pathology field development.

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Competing interests

The authors declare no competing interests.

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