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Preference and Demand for Digital Pathology and Computer-Aided Diagnosis among Korean Pathologists: A Survey Study Focused on Prostate Needle Biopsy

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Abstract: Digital pathology systems (DPSs) have been globally implemented, and computer-assisted diagnosis (CAD) software has been actively developed in recent years. This study aimed to investigate perceptions of digital pathology and the demand for CAD. An online survey involving members of the Korean Society of Pathologists was conducted, and a demonstration clip of the diagnostic assistant software for a prostate needle biopsy was shown to them to provide a simple experience with CAD. One hundred sixty-four Korean pathologists (13.6% of 1210 Korean pathologists) participated. The majority (77.4%) answered affirmatively regarding the necessity of implementing a DPS, and 26.8% had plans to implement or increase the use of DPSs in the following 2–3 years at their medical institutions. Pathologists felt that multidisciplinary care or conference accessibility (56.7%), remote consultation (49.4%), and big data building (32.9%) were useful parts of DPSs. Most pathologists (81.7%) responded that CAD software would assist with the diagnostic process. In a prostate needle biopsy, pathologists used the software to improve the measurement of tumor volume and/or length and core length but not to suggest a diagnostic name or Gleason grade. Korean pathologists who participated in the survey had highly positive perceptions of digital pathology and maintained a positive attitude toward the use of CAD software.

Keywords: pathologists; surveys and questionnaires; digital pathology; computer-assisted diagnosis; prostatic neoplasms

1. Introduction

Digital pathology has been actively implemented in recent years at many hospitals in Korea as well as in other countries around the world. Implementation of these systems has been facilitated due to technological developments in whole-slide imaging, file compression, data streaming, fair storage server costs, and connection of worldwide Internet networks [1–3]. Many software programs for computer-aided diagnosis (CAD) have been developed, and clinical use of such software has been made feasible by the advent of deep learning technologies in the image processing domain [4,5].

There have been many discussions about the importance and effectiveness of digital pathology and CAD during the process of implementing digital pathology. However, during the implementation process, the order of implementation or the parts that are

focused on may differ by country or region since each location has different medical systems, hospital systems, and degrees of expertise among pathologists [6,7]. Thus, a variety of strengths and concerns about digital pathology should be considered and carefully designed location-specific approaches used when implementing strategies to satisfy unmet needs. Nevertheless, practical surveys of pathologists regarding these unmet needs are limited.

Although white papers and reviews have been published by hospital sites utilizing digital pathology, information on pathologists' recognition of and demand for digital pathology remains sparse. Furthermore, most pathologists lack the opportunity and experience to discuss or comment on CAD because there is little research on the development of CAD systems that are actually being used in the diagnostic process.

Recent research has demonstrated the viability of CAD software for prostate cancer diagnosis, which is one of the few medical fields where practical technologies for digital pathology are being introduced at an increased pace [8,9]. Indeed, a prostate needle biopsy is one of the areas where CAD is being developed at the highest level; however, there are significant discrepancies among pathologists, and prostatic cancer is a subject that requires considerable effort for diagnosis [10,11]. Thus, CAD targeting prostate needle biopsy is a good example to provide pathologists with an opportunity to experience CAD software and to evaluate their perceptions of CAD in detail. In addition, almost all Korean pathologists share the same experiences with regard to prostate cancer diagnosis, and we have developed an artificial intelligence (AI)-based diagnostic assistant software for a prostate needle biopsy that is currently undergoing a clinical trial called PROMISE-P.

We conducted an online survey of Korean pathologists to investigate their perceptions of and demand for digital pathology and CAD. At the time of the survey, a demonstration clip of the diagnostic assistant software for a prostate needle biopsy was shown to them to provide a simple experience with CAD.

2. Materials and Methods

2.1. Dr. Answer™ Project and PROMISE-P Software

The Dr. Answer™ project is a national medical software service development project that supports doctors' diagnosis and treatment using medical big data and AI technology and is led by Korean tertiary medical institutions. From 2018 to March 2021, this project has focused on 8 major diseases, including cardiocerebrovascular disease, heart disease, breast cancer, colorectal cancer, prostate cancer, dementia, epilepsy, and pediatric rare and intractable genetic disease. A total of 27 medical institutions and 17 medical-related information technology companies are participating.

PROMISE-P is a deep learning-based CAD software for assistance in prostate cancer diagnosis via a prostate needle biopsy [12,13]. PROMISE-P automatically analyzes the digital slide images of the prostate needle biopsy as follows: the software informs the user about the presence or absence of cancer and displays the high cancer risk area as a heatmap. Dr. Answer™ PROMISE-P is currently undergoing clinical trials with approval from the Korea Food and Drug Administration.

This study was approved by the Institutional Review Board of The Catholic University of Korea Yeouido St. Mary's Hospital (approval number, SC19QISI0138).

2.2. Survey Design Outlines

This survey targeted Korean pathologists with the cooperation of The Korean Society of Pathologists for the successful development of PROMISE-P. From the perspectives of pathologists, this survey was planned and executed to evaluate pathologists' discomfort when reading a prostate needle biopsy, to determine the expected benefits of CAD software and obstacles to its introduction, and to understand the acceptability of PROMISE-P and pathologists' preferences for digital pathology and CAD.

The target population for this survey was pathologists, including residents and specialists working in Korea who were members of The Korean Society of Pathologists. Almost

all Korean pathologists are members of The Korean Society of Pathologists because Korean pathologists are obligated to join this society.

Data were collected from a total of 1210 members of The Korean Society of Pathologists by sending an e-mail with a link to an online survey, and the standard sampling method was convenience sampling. The term of the survey began on 27 July 2020 and ended on 24 August 2020. A total of 164 samples were valid; thus, the response rate was 13.6%.

The content of the questionnaire included questions about the general part of the clinical implementation of the digital pathology system (DPS), general perceptions of CAD software and the use of CAD software for a prostate needle biopsy, and opinions on Dr. Answer™ PROMISE-P. (Supplementary Material 1) The survey participants were asked to watch a video about Dr. Answer™ PROMISE-P and then answer the questionnaire. This video can be found here: (https://youtu.be/BOOe3USdC44 (accessed on 4 August 2021)) (Supplementary Material 2).

3. Results

3.1. Participant Demographics

Pathologists in Korea are largely divided into pathologists working at reference laboratories and pathologists working at hospitals, and all pathology residents work at hospitals. The reference laboratory receives referred specimens from local clinics for pathologic diagnosis. The majority of pathologists working at hospitals work at university hospitals, and a few pathologists work at small- and medium-sized hospitals.

Pathologists worked as trainees, such as residents and fellows, faculty, or hospital pathologists at universities and/or tertiary hospitals. Some pathologists worked in small- and medium-sized hospitals, and generally, there were no more than 4 pathologists working at each hospital. A hospital pathologist was designated as a pathologist who worked at any sized hospital and excluded trainees and faculty members.

Among the survey respondents, female pathologists accounted for 59.1%. The participation rates of pathologists younger than 30 years and those who had less than 10 years of experience as a doctor, including training doctors such as interns and residents, were high at 45.1% and 43.3%, respectively. When analyzed by subspecialty, general surgical pathologists and gastrointestinal (GI) pathologists were common and accounted for 46.6% and 16.7% of participants, respectively. The criteria for junior and senior pathologists were analyzed based on 20 years of experience. (Table 1).

3.2. Preferences for and Perception of Digital Pathology

Of all survey participants, 77.4% of pathologists answered that it was necessary to implement a DPS. (Figure 1a) Approximately 26.2% answered that they were already using DPSs for research and/or diagnostic practices in whole or in part; 26.8% reported that they were planning to implement or increase the use of DPSs in the next 2 or 3 years (Figure 1b).

When pathologists were asked about their expectations upon implementation of a DPS, the most promising aspects were thought to be the 'ability to browse digital slides', 'accessibility of multidisciplinary team care and conferencing', and 'increased ease of consultation with an expert'. Their expectations for 'workload reduction' or 'improved diagnostic accuracy' were relatively low. (Figure 1d) The most promising benefits of a DPS depended on the career and position of the pathologist. (Table 2).

Regarding concerns about DPSs, many responders were concerned about the 'high initial investment', 'increased workload from new tasks', and 'increased turnaround time (TAT)' (Figure 1e).

Pathologists who had positive expectations of DPSs expected 'work process efficiency' more than 'reference to digital slides' and 'accessibility of multidisciplinary team care and conferencing'. In the group that responded moderately or negatively to DPSs, their expectations for 'increased ease of consultation with an expert' were relatively high. (Figure 1f) Pathologists who had positive expectations about DPSs were most concerned about the 'high initial investment' and 'increased risk of leaking personal information'.

Moreover, pathologists who responded moderately or negatively to DPSs thought that DPSs were not necessary for practical diagnosis. (Figure 1g) Pathologists who had positive expectations about DPSs but did not have specific plans to implement them had relatively more concerns about the 'high initial investment' than pathologists who planned to implement them within 2–3 years (data not shown).

There were different hurdles to the introduction and utilization of a DPS (Figure 2). Approximately 79.1% of the respondents working at medical institutions that had adopted DPSs were satisfied with their DPSs, indicating that their satisfaction with DPSs was quite high (Figure 1c). Regardless of whether a medical institution had implemented a DPS, the most considerable obstacle to the introduction of a DPS was covering all the expensive introduction costs with the medical institution's own budget without support from a public insurance system (Figure 2a,c).

3.3. Preferences for and Perceptions of Using CAD Software in Prostate Needle Biopsy

Prostate needle biopsy is generally performed with 12 core biopsies, and in some cases, up to 14 core biopsies. Pathologists struggled the most when reading prostate needle biopsies with 'measuring the tumor volume for each core' and 'measuring the lesion length and core length'. They answered that difficulties with 'making a pathological diagnosis or 'defining the Gleason score and/or grade group' were not significant (Figure 3a). By subspecialty, uropathologists responded that 'measuring the tumor volume' and 'measuring the tumor length and core length' were cumbersome, and relatively few uropathologists responded that 'making a pathological diagnosis' was difficult (Table 3).

Table 1. Demographic characteristics.

		Number (%)
Sum		**164 (100)**
Gender	Male	67 (40.9)
	Female	97 (59.1)
Age	Younger than 30 years	74 (45.1)
	30–40 years	46 (28)
	Older than 50 years	44 (26.8)
Career	10 years or shorter	71 (43.3)
	Between 11 to 20 years	49 (29.9)
	21 years or longer	44 (26.8)
Position	Resident	31 (18.9)
	Fellow	15 (9.1)
	Hospital pathologist	22 (13.4)
	Faculty	74 (45.1)
	Reference laboratory	22 (13.4)
Specialty [1]	General surgical pathology	81 (46.6)
	Uropathology	18 (10.3)
	Gynecopathology	15 (8.6)
	Gastrointestinal (GI) pathology	29 (16.7)
	Pulmonary pathology	16 (9.2)
	Hematopathology	15 (8.6)
	Molecular pathology	19 (10.9)
	Other specialty	59 (33.9)

[1] The selection of specialty had multiple responses, and if the frequencies of each specialty are added, it does not match the total effective sample size.

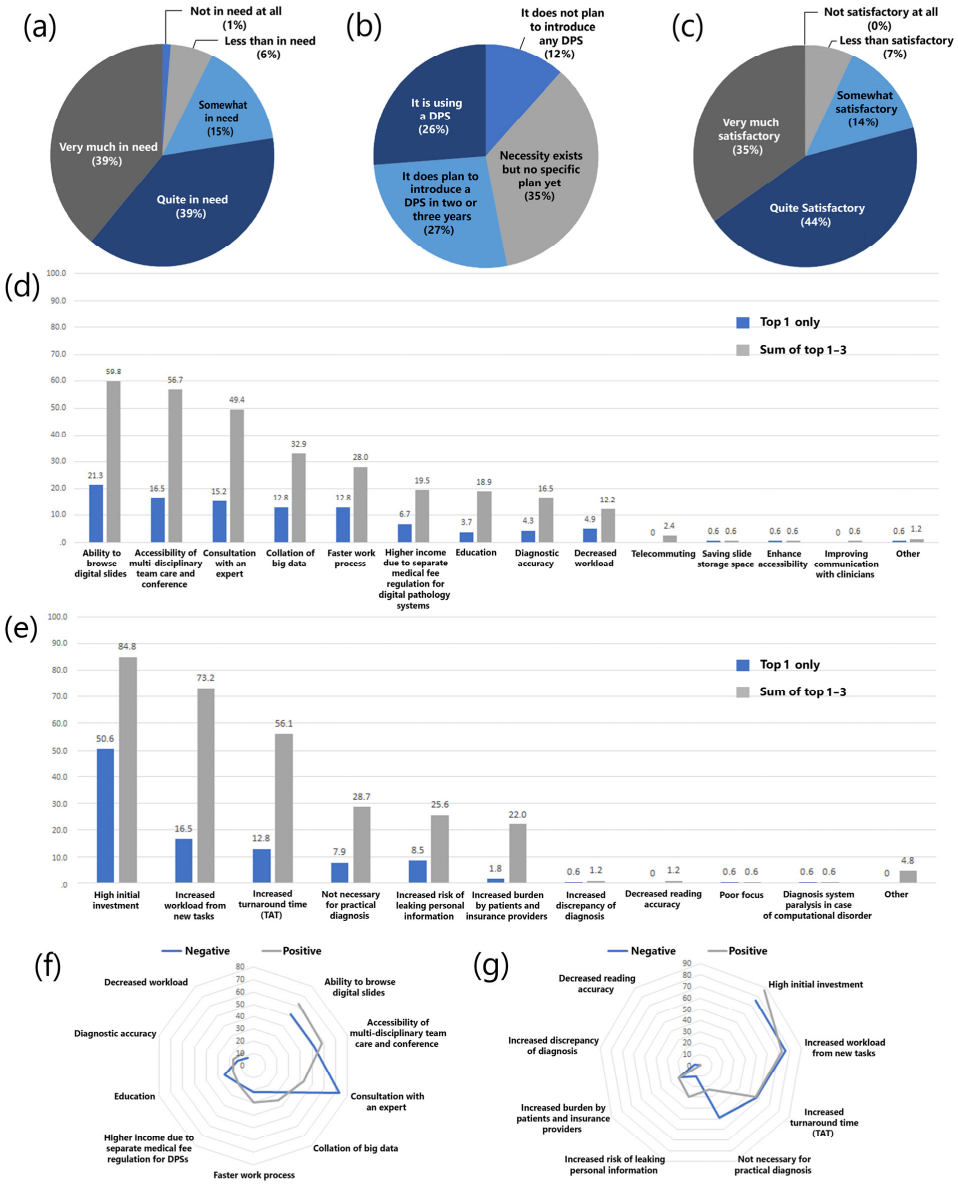

Figure 1. Expectations and concerns regarding digital pathology system (DPS) introduction. Expectations and concerns regarding digital pathology system (DPS) introduction. (**a**) Recognition of the need to introduce a digital pathology system (DPS). Positive perceptions about the necessity of a DPS accounted for 77.4%. (**b**) Plan to implement a DPS. Fifty-three percent of pathologists answered that they had introduced a DPS or had plans to introduce a DPS within 2–3 years. (**c**) Satisfaction with an introduced DPS. As a result of actually introducing and using digital pathology, 79.1% of pathologists tended to be satisfied. (**d**) Expected benefits of introducing a DPS. During the introduction of a DPS, pathologists had the highest expectations for the 'ability to browse and read digital slides' and 'accessibility to multidisciplinary team care and conferencing'. (**e**) Concerns about introducing a DPS. The most considerable obstacle to the introduction of a DPS was the expensive introduction cost. (**f**) Comparison of expected benefits by recognition of the need to introduce a DPS. In the case of positive responses regarding the necessity of introducing a DPS, participant expectations were high for the 'ability to read digital slides', 'accessibility to multidisciplinary team care and conferencing', and 'faster work process'. In contrast, when the responses were negative regarding the necessity of introducing a DPS, their expectations were relatively high for 'consultation' and 'education'. (**g**) Comparison of concerns by recognition of the need to introduce a DPS. In cases of positive responses regarding the need to introduce a DPS, concerns about the 'high initial investment' and 'risk of leaking personal information' were high. In many cases of negative responses regarding the need to introduce a DPS, pathologists expected that a DPS would be 'unnecessary for practical diagnosis'. (**f**,**g**) Negative includes 'Not in need at all', 'Less than in need', and 'Somewhat in need' and positive includes 'Quite in need' and 'Very much in need' of Figure 1a.

Table 2. Expected benefits of introducing a digital pathology system (DPS) by career and position.

	Sum	Resident	Fellow	Hospital Pathologist	Junior Faculty	Senior Faculty	Junior Pathologist at a Reference Laboratory	Senior Pathologist at a Reference Laboratory
Base for % [1]	(164)	(31)	(15)	(22)	(43)	(31)	(16)	(6)
Expected benefits of introducing a digital pathology system (DPS) (Sum of top 1~3 in percentage)								
Ability to browse digital slides	59.8	77.4	80.0	36.4	60.5	45.2	68.8	50.0
Accessibility of multidisciplinary team care and conferencing	56.7	38.7	73.3	54.5	62.8	87.1	18.8	16.7
Consultation with an expert	49.4	19.4	46.7	68.2	44.2	61.3	56.3	100.0
Collation of big data	32.9	32.3	33.3	27.3	41.9	29.0	37.5	0.0
Faster work process	28.0	64.5	13.3	31.8	20.9	9.7	31.3	0.0
Higher income due to separate medical fee regulation for DPSs	19.5	16.1	6.7	18.2	25.6	16.1	37.5	0.0
Education	18.9	25.8	26.7	9.1	14.0	32.3	0.0	16.7
Diagnostic accuracy	16.5	16.1	6.7	22.7	14.0	6.5	31.3	50.0
Decreased workload	12.2	6.5	13.3	22.7	9.3	12.9	12.5	16.7
Other (telecommuting, decreased slide storage space, etc.)	6.1	3.2	0.0	9.1	7.0	0.0	6.3	50.0

[1] The positions with sample sizes that are statistically not large enough are denoted.

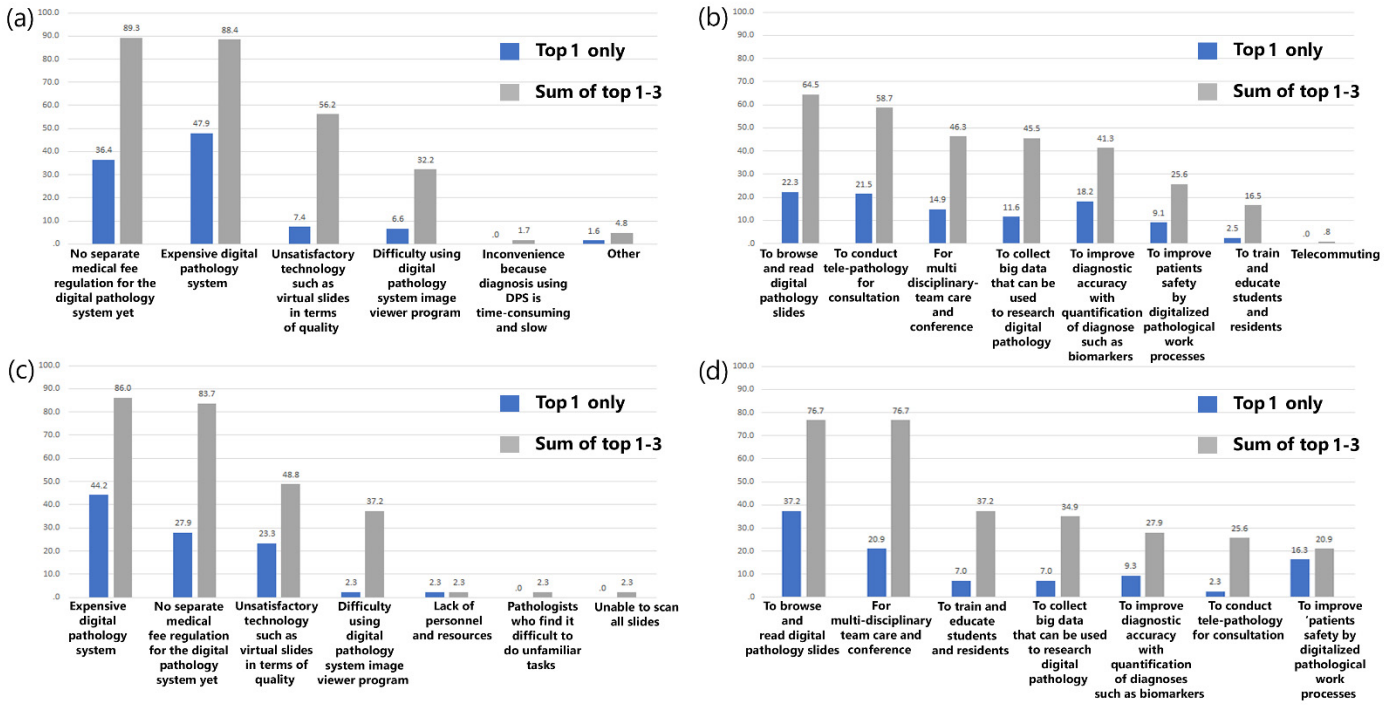

Figure 2. Hurdles to DPS introduction according to DPS experience levels. (**a**) Expected hurdles when introducing a DPS. In the case of pathologists without experience using a DPS, the most considerable obstacle to introducing a DPS was the 'lack of separate medical fee regulation for DPSs' and 'expensive DPSs'. (**b**) Expected use when introducing a DPS. In the case of pathologists without experience using a DPS, they expected that if a DPS was introduced, it would have the following functions: 'ability to browse and read digital slides', 'telepathology for consultation', and 'accessibility to multidisciplinary team care and conferencing'. (**c**) Hurdles in the practical introduction of a DPS. In the case of pathologists who had introduced and used a DPS, the most considerable obstacle to the introduction of a DPS was the expense. (**d**) Use of practical applications of a DPS. In the case of pathologists who had introduced and used a DPS, DPSs were used to 'browse and read digital slides', provide 'multidisciplinary team care and conferencing', and 'train and educate students and residents'.

Pathologists responded that the most important functions for prostate cancer CAD software were 'measuring the tumor volume', 'measuring the tumor length and core length', 'indicating the existence/exact location of lesions', 'counting the number of lesions', 'analyzing treatment-related biomarkers', and 'defining the Gleason score and/or grade group' (Figure 3b).

Survey participants most expected to secure 'accuracy and reproducibility of measurements such as lengths and percentages', 'increased ease of measurement', and 'increased convenience for reading and diagnosis,' while they rarely expected 'decreased reading and diagnosis time' and 'reduced workload' when applying CAD software. (Figure 3c) Uropathologists had fewer expectations of 'decreased reading and diagnosis time' than other subspecialties, but they had higher expectations of 'improved diagnostic accuracy' and 'accuracy and reproducibility of measurements' (Table 3).

When CAD software was applied, 67.1% of pathologists expected a gradual decrease in workload after an initially increased workload (Figure 3e). The use of CAD software, particularly among senior pathologists, was positively recognized by most pathologists (Figure 3d).

3.4. Preferences for Dr. Answer™ CAD Software for Prostate Needle Biopsy 'PROMISE-P'

Responding pathologists expected that the use of Dr. Answer™ PROMISE-P would improve the overall diagnostic quality, but their expectations regarding decreased reading

time were relatively low. The uropathologist group expected that the use of PROMISE-P would improve the overall diagnostic quality compared with other pathologists but had low expectations regarding the comprehensive readability of evaluating various diagnostic factors conducted by pathologists (Table 4).

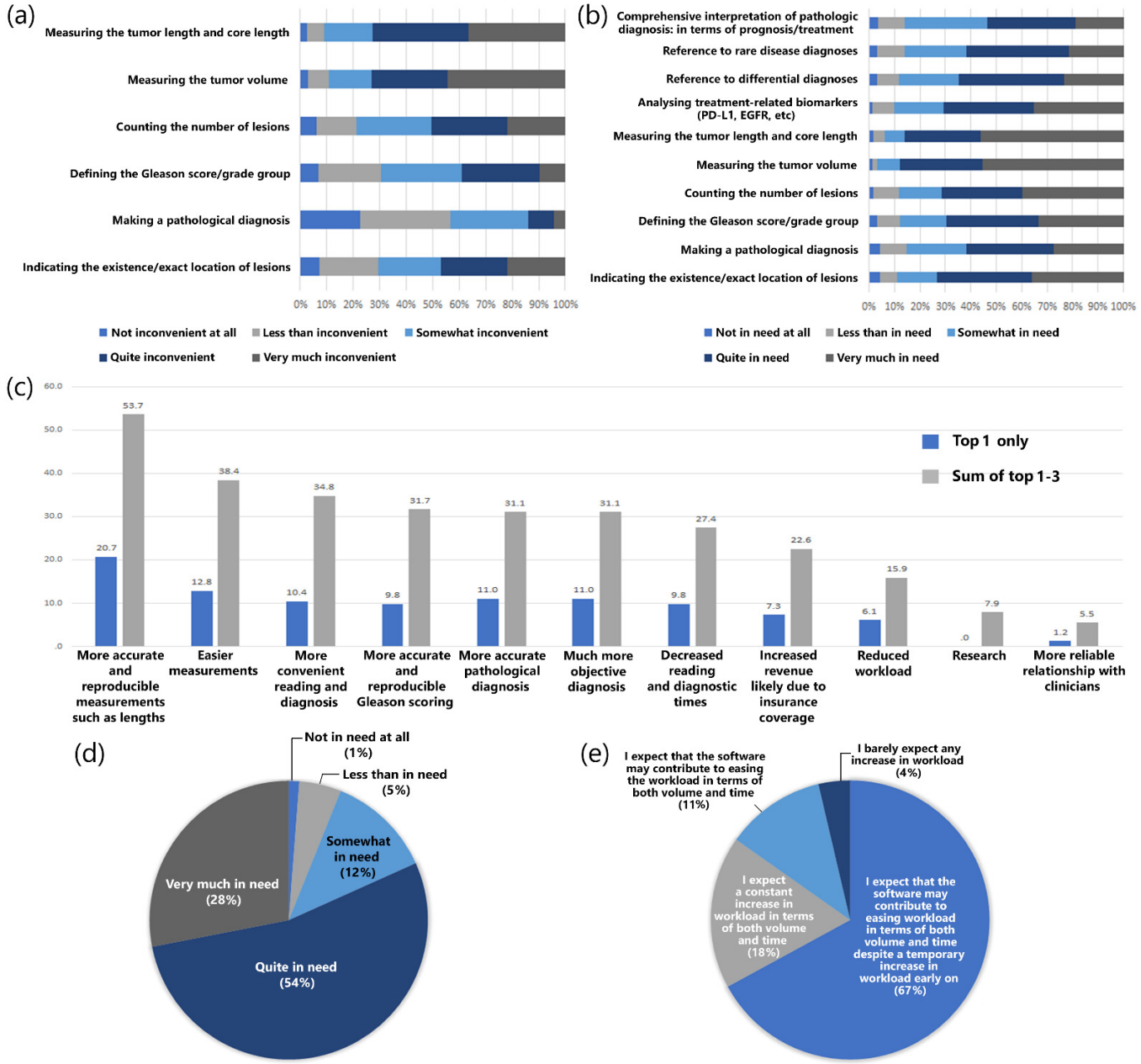

Figure 3. Expectations and concerns with computer-aided diagnosis (CAD) software for a prostate needle biopsy. (**a**) The degree of discomfort by readout items of a prostate needle biopsy. When diagnosing prostate needle biopsy specimens, pathologists responded that 'measuring the tumor volume' and 'measuring the tumor length and core length' were the most inconvenient aspects. (**b**) Required capabilities for prostate needle biopsy CAD software. In prostate needle biopsy CAD software, pathologists responded that the function of 'measuring the tumor length and core length' was necessary. (**c**) Expected benefits of CAD software. If prostate needle biopsy CAD software is developed, pathologists had high expectations for assisting in 'easier measurements' and facilitating 'more accurate and reproducible measurements'. (**d**) Additional work burden incurred with the introduction of CAD software. Approximately 67.1% of pathologists responded that the initial workload would increase but decrease subsequently if CAD software was introduced. (**e**) Recognition of the need to introduce reading aid software. Approximately 81.7% of pathologists thought that they needed CAD software.

Table 3. The inconvenience of prostate needle biopsy diagnosis and the expected benefits of prostate needle biopsy CAD software by specialty.

	Sum	Resident & Fellow	General Surgical Pathology	Uropathology	Other Specialty
Base for %	(164)	(46)	(45)	(12)	(61)
Inconvenience factors of prostate needle biopsy diagnosis (average per 100 points)					
Indicating existence/exact location of lesions	47.0	61.41	53.33	47.92	61.07
Making a pathological diagnosis	14.0	39.13	33.89	20.83	34.84
Defining the Gleason Score/grade group	39.0	51.63	53.33	41.67	55.74
Counting the number of lesions	50.6	58.70	60.00	64.58	63.52
Measuring the tumor volume	73.2	67.39	76.11	85.42	80.33
Measuring the tumor length and core length	72.6	69.57	73.33	87.50	76.23
Expected benefits of prostate needle biopsy CAD software (Sum of top 1–3 in percentage)					
More accurate and reproducible measurements such as lengths and percentages	53.7	56.5	48.9	66.7	52.5
Easier measurements	38.4	34.8	37.8	41.7	41.0
More convenient reading and diagnosis	34.8	47.8	26.7	25.0	32.8
More accurate and reproducible Gleason scoring	31.7	19.6	37.8	33.3	36.1
More accurate pathological diagnosis	31.1	28.3	26.7	50.0	32.8
Much more objective diagnosis	31.1	30.4	26.7	33.3	34.4
Shortened reading and diagnostic times	27.4	26.1	28.9	8.3	31.1
Increased revenue likely thanks to insurance coverage	22.6	19.6	28.9	25.0	19.7
Reduced workload	15.9	23.9	17.8	8.3	9.8
Research	7.9	8.7	13.3	8.3	3.3
More reliable relationship with clinicians	5.5	4.3	6.7	0.0	6.6

Table 4. The expected usefulness of Dr. Answer™ PROMISE-P by specialty.

	Sum	Resident + Fellow	Surgical Pathology	Uropathology	Other Specialty
Base for %	(164)	(46)	(45)	(12)	(61)
Perceived usefulness of Dr. Answer™ PROMISE-P (average per 100 points)					
Decreased diagnostic time	45.1	56.5	42.2	50.0	37.7
Improved diagnostic quality	67.1	65.2	66.7	75.0	67.2
Smooth and effective diagnosis	55.5	56.5	53.3	50.0	57.4
Comprehensive diagnosis	53.7	50.0	48.9	41.7	62.3
Convenient diagnosis	53.7	54.3	51.1	50.0	55.7
Intention to use Dr. Answer™ PROMISE-P (average per 100 points)					
Intention to introduce	43.9	50.00	40.00	58.33	39.34
Intention to diagnose	57.9	56.52	55.56	66.67	59.02
Accurate diagnosis and utilization of patient information	51.8	50.00	53.33	58.33	50.82
Intention to use continuously	50.6	50.00	53.33	66.67	45.90
Intention to recommend	42.1	43.48	46.67	50.00	36.07
Willingness to continue using	33.5	30.43	44.44	25.00	29.51
Willingness to spread positive word of mouth	44.5	45.65	51.11	50.00	37.70
Reduced workload you can expect when using Dr. Answer™ PROMISE-P (percentage)					
Expected reduced working hours	21.2	25.87	16.56	28.75	19.51
Improved pathological accuracy you can expect when using Dr. Answer™ PROMISE-P (percentage)					
Expected accuracy	26.9	26.96	24.44	33.75	27.30
Improved convenience you can expect when using Dr. Answer™ PROMISE-P (percentage)					
Expected convenience	26.9	29.52	27.67	35.42	28.03
Reduced diagnostic time you can expect when using Dr. Answer™ PROMISE-P (percentage)					
Expected reduced diagnosing hours	26.9	22.20	17.69	16.67	19.84

4. Discussion

Korean pathologists showed high positive expectations for implementing a DPS, but the main reasons for implementing a DPS differed according to the types of medical institutions where they worked and their careers. Pathologists placed high significance on digital pathology to be able to view pathologic images in a digitized form without finding an individual patient's glass slides in a warehouse.

Pathologists had low expectations regarding the use of CAD to lead to reduced work hours or workload. However, the group that responded positively regarding DPS implementation had relatively high expectations for reduced work hours and workload. Pathologists working at medical institutions using digital pathology showed higher satisfaction with DPSs than pathologists working at institutions that did not use them.

Although many pathologists were positive about DPSs, pathologists thought that the most considerable obstacle to the introduction of these systems was the high introduction cost. In particular, in Korea, DPS implementation is entirely borne by the medical institution that introduces the program; thus, each medical institution has a considerable burden for system introduction.

A reduction in the high initial investment can be accomplished through the provision of incentives for hospitals by creating pathological 'big data' and academic alliances of companies and/or academia, establishing a nationwide DPS infrastructure, and, in the long run, improving market participation of more scanner manufacturers and DPS developers.

In this survey, some pathologists were concerned that the implementation of digital pathology could increase pathologists' workload. In particular, the group who had negative perceptions of implementing digital pathology had low expectations for a reduced workload and working hours, while their expectations for the use of DPSs in consultation and education tended to be high. Therefore, to increase positive perceptions of digital pathology among more pathologists, demonstrating and practically promoting that the introduction of digital pathology can actually reduce pathologists' workload and working hours is important. It may also be necessary to provide a national or global interface of DPSs for consultation and education. When implementing a DPS, conducting systematic and repetitive education for pathologists considering their IT proficiency is necessary. In addition, considerable effort is needed to customized programs that can be interfaced with each hospital's own medical record system.

To date, data on the merits of digital pathology from commercial companies that provide digital pathology have suggested the overall efficiency of pathologic diagnosis. However, there has been not much evidence of a reduced pathologist workload or the convenience of using CAD software considering the medical system of each country [14–16]. This may be because few hospitals have introduced and implemented DPSs in the overall workflow of their pathology departments and because CAD software other than morphometric software is also rarely used. To date, CAD software has been developed with a focus on naming or grading malignancies; however, pathologists had many demands that various prognosis- and treatment-related characteristics be present on pathology diagnostic reports. Considering this, future CAD software will need to be developed based on these unmet needs for various convenient functions to help pathologists in the process of preparing diagnostic reports.

Since the incidence of prostate cancer is high, most cases are adenocarcinoma, and the histological grading and reporting guidelines are well established, and many studies using digital pathology have been conducted from the early days of the introduction of AI in the pathology field [17]. Most studies on prostate cancer have been aimed at accurate cancer segmentation and Gleason grade/grade group suggestion [5,8–11]. However, this survey of CAD software for a prostate needle biopsy demonstrated that pathologists need the software to assist with inconvenient measurement of tumor volume and/or length and core length rather than to assist with the suggestion of a diagnostic name or Gleason grade. In particular, uropathologists who are mainly responsible for the diagnosis of prostate needle biopsies complained about inconvenient measurement and suggested

the need for software that could assist with this cumbersome measurement. In addition, most pathologists were also interested in improving the accuracy and reproducibility of measurements using CAD software. Thus, pathologists are having trouble with manual measurements using glass slides, marker pens, and rulers and are dissatisfied with the low accuracy and reproducibility of these measurements. In other words, most of the software developed to date is diagnosis-oriented; however, pathologists have high demands for assistance with generating diagnostic reports.

Although Dr. Answer™ PROMISE-P was a relatively simple software that only functioned for cancer segmentation, many pathologists had positive perceptions of this software. In particular, pathologists' expectations and positive perceptions of Dr. Answer™ PROMISE-P were higher among uropathologists than among other pathologists. With regard to PROMISE-P, better evaluation may have been achieved if only uropathologists had been surveyed and if more had participated. However, the lack of a measurement function in Dr. Answer™ PROMISE-P software, for which pathologists showed high demand, was thought to be the cause of their low intentions to introduce and continue to use the software.

This study was meaningful because it grasped the needs of pathologists who are the actual consumers. However, a limitation of this study was that the survey was conducted with only a Korean pathologist group and a limited number of survey participants. It was also predictable that participation of pathologists with negative perceptions of digital pathology in this survey would be poor. However, useful tips for digital pathology-related companies or academies' product development trends and research directions could be suggested by demonstrating pathologists' perceptions of digital pathology and pathology CAD software, including prostate needle biopsy software.

5. Conclusions

Korean pathologists had highly positive perceptions of digital pathology and maintained positive attitudes regarding the use of CAD software, as evidenced by this survey. They seemed to have many demands for CAD software with various convenient functions to help pathologists in the process of preparing diagnostic reports. In particular, due to the difficulty of the diagnostic process for a prostate needle biopsy, the expected benefits of Dr. Answer™ PROMISE-P were measurement functions for tumor volume, lesion length, and core length, accuracy and reproducibility of measured values, and convenient reading and diagnosis. Therefore, when developing and distributing CAD software for a prostate needle biopsy, accurate and convenient measurement functions should be considered first. In addition, because pathologists' satisfaction was high after the introduction of a DPS, if pathologists' requests for CAD software were reflected in the development process, if a convenient interface with a DPS was established, if opportunities to experience the software and appropriate user education were provided, CAD software could be spread to clinical practice. Therefore, active communication between pathologists and developers is necessary to grasp the unmet needs of pathologists when developing CAD software.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/app11167380/s1, Supplementary Material 1: Questionnaire used in the study (English translation). Supplementary Material 2: Screenshots of Dr. Answer™ PROMISE-P.

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