Efficacy of Fluoroscopic Screen Capture Images in Evaluation of Abnormality during Voiding Cystourethrography in Pediatric Population

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Background: *Children's risk of adverse radiation effects is greater than adults. All radiologic examinations should be performed with lowest radiation dosage possible. Screen image capture is a new way for image documentation that could minimize radiation exposure during voiding cystourethrography (VCUG).*

Objective: *To evaluate the effectiveness of fluoroscopic capture spot (FCS) image in diagnosing vesicoureteral reflux (VUR) and other urinary tract pathologies during VCUG in the pediatric population.*

Material and Method: *The study was done prospectively in 248 VCUG examinations. Each test consisted of FCS images and the corresponding digital radiographic spot (DRS) images taken nearly simultaneously. Each set of data was reviewed by three pediatric radiologists for the diagnosis of VUR, urinary tract pathologies, presence of a fistula, and other abnormalities. By using DRS images as a gold standard, the effectiveness of FCS images was evaluated. The present study protocol was approved by the Ethics Committee of Faculty of Medicine Siriraj Hospital, Mahidol University (Si073/2012).*

Results: *There was no significant difference between FCS and DRS images in defining grade of VUR (p = 0.194). FCS and DRS diagnostics were in perfect agreements when diagnosing the presence or absence of VUR, urinary tract pathologies (kidney, ureter, bladder, urethra), presence or absence of fistula, and other abnormalities. When images classified as non-significant VUR (no VUR, grade 1 VUR) or significant VUR (VUR grade 2-5), accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for diagnosing the non-significant VUR were 99.1%, 100%, 96.7%, 98.9%, and 100%, respectively. When images classified as negative/ low-grade VUR (grade 1-2) or moderate/high grade VUR (VUR grade 3-5), accuracy, sensitivity, specificity, PPV, and NPV for diagnosing negative/low-grade VUR were 99.7%, 100%, 98.8%, 99.8%, and 100%, respectively. There were excellent correlations among three readers.*

Conclusion: *Image from fluoroscopic capture spot technology is sufficient to diagnose VUR and non-VUR urinary tract abnormality on VCUG examination.*

Keywords: *Voiding cystourethrography, Vesicoureteral reflux, Radiation dose reduction, Children, Urinary tract abnormality*

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The voiding cystourethrography (VCUG) plays an important role in pediatric patient care. It is frequently used for evaluation of the urinary tract in children. It can demonstrate not only anatomic abnormalities but also provide physiologic information such as vesicoureteral reflux (VUR) and bladder function. Its common indications include urinary tract infection, hydronephrosis, suspicious urinary tract anomaly, and urinary tract trauma.

According to the "as low as reasonably achievable" (ALARA) principle, ionizing radiation during the radiologic examination should be used as low as possible to minimize short and long-term radiation adverse effects to children. However, radiation reduction technique should not affect diagnostic quality[1].

The VCUG examination typically entails a minimum of 30 to 60 seconds of fluoroscopy including four to six digital radiographic spots (DRS)[2]. Radiation exposure per examination, approximately 30 to 50 mSv, depends on fluoroscopic time and number of DRS image[3,4]. There are many techniques to reduce ionizing radiation during examination including reduction of fluoroscopic time, avoiding using grid, minimizing source to skin distance, pulsed fluoroscopy technique, and fluoroscopic capture spot (FCS) (last image hold) technology[3,5,6]. The FCS enables the last image of a digital fluoroscopic exposure to be displayed on a monitor and subsequently save and store to picture

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archiving and communication system (PACS). This technique allows the radiologist to store fluoroscopic image displayed on the monitor with no additional ionizing radiation. Although these images are noisier and have lower quality than DRS images, abnormalities on VCUG study can be easily identified by FCS images in most cases. Fefferman et al (2009)[2] and O'Connor et al (2004)[7] reported that FCS images could replace DRS images for the documentation on VCUG.

There are few studies that reported the value of FCS in diagnosing VUR[2,7]. Unfortunately, these studies are retrospective designed and have small sample size. In addition, FCS images in these studies were taken randomly depending on the judgment of the performing radiologists. These FCS images cannot be directly compared to DRS images because they were not taken at the same time. The author intended to perform the present study prospectively with larger sample size (n = 248). On each VCUG examination, the FCS and DRS images were intentionally taken nearly at the same time to ensure the comparison accuracy. In addition, the present study also analyzed the value of FCS images for diagnosing non-VUR lesions.

The primary purpose of the present study was to determine the effectiveness of FCS images with those of DRS images in evaluating VUR. The secondary purpose was to compare the effectiveness of FCS images in evaluating other abnormalities with those of DRS images on VCUG examination.

Material and Method

The present study protocol was approved by the Ethics Committee of Faculty of Medicine Siriraj Hospital, Mahidol University (Si073/2012). The details of the research (research title, objectives of the research, medical procedures, rights of withdrawal, medical and legal risks) were informed and discussed with the patient's legal guardians and the patients themselves (if possible, in simple language). They were requested to sign that all the information had been provided during the discussion. If the patient's legal guardians decided to participate the project, they were requested to sign permission in the consent forms. If the participants were older than seven years old, both patients and their legal guardians are requested to sign permission in the consent forms before performing any medical procedures.

The study was done prospectively in 248 VCUG examinations performed in children younger than 15 years old between February and November 2013 in the Department of Radiology, Siriraj Hospital, Mahidol University. Inform consents were obtained in all examinations. The study population included pediatric inpatients and outpatients, less than 15 years of age, whom the pediatrician sent to the radiology department for VCUG. The cases whose FCS images or DRS images were not available (data loss, unrecorded), whose demographic data were missed, who refused to sign the informed consent, and who requested for withdrawal were excluded from the study. All VCUG examinations were performed as part of routine investigation of the patient and did not pose any risk to patients.

All VCUG examinations were performed with Philips digital fluoroscopy system (EasyDiagnost Eleva DRF, Philips Healthcare, Bangkok, Thailand). All parameters were intentionally adjusted to the lowest radiation exposure available in our equipment. The fluoroscopic parameters setting include matrix (512x512), fluoroscopic flavor (low dose), and fluoroscopic frame speed (one pulse per second). The DRS parameters include kV-mA adjustment (automatic), exposure dose level (low dose), exposure type (single exposure), and focal spot size (small).

All VCUG examinations were performed by using the ratio of water soluble contrast media (TELEBRIX 370) to 0.9% normal saline equal to 1:3. The amount of water-soluble contrast used in each examination was calculated by using expected bladder capacity for age. The formulas for bladder capacity are bladder capacity (cc) = (age (year) + 2) x 30 in case of patient's age of one year and older, and bladder capacity (cc) = weight (Kg) x 7 in case of patient's age less than 1 year[8].

Either feeding tube number 5 or 8 French scales was used for urethral catheterization. Sizes of the feeding tube used in these examinations were carefully selected depending on the judgment of performing radiologists. The examination consisted of the standard spot images including scout images, bladder image during contrast filling, oblique views of right and left ureterovesical junctions, bladder images during fully distended bladder, voiding images of urethra, and right and left renal beds as well as any additional images necessary to document pathology. All DRS images obtained in these examinations had accompanied FCS images taken immediately after DRS images were obtained.

All the examination images were divided into two data sets. The first data set consisted of DRS images and the other consisted of FCS images. The

DRS images were sent to hospital's routine PACS (Synapse, FUJIFILM Corporation, Tokyo, Japan) while FCS images were sent to the independent server built specifically for the present research.

The images from all VCUG examinations were reviewed separately by three pediatric radiologists with experience from 2 to 15 years (Neungton P, Pacharn P, and Iemsawatdikul K). All the images were assigned to radiologists for reading in random order. While radiologists reviewed images from each data set, they were not allowed to see the images from the other data set. The radiologists were assigned to record information including numbers of image, presence or absence of VUR, grade of VUR in each kidney/ureter unit using international reflux system[9], anatomic abnormality of kidney, ureter, bladder, urethra or others, presence or absence of fistula. The data sets were reviewed in two sessions, separated by a minimum of two months, with the FCS images data set reviewed first, to eliminate any memory bias.

If there were discrepancies among readers, the images will be re-evaluated to make the final agreement.

Statistical analysis

Intraclass correlation was used to evaluate inter-observer variability, Wilcoxon test used to evaluate the difference of VUR grading between DRS and FCS images, and McNemar's test used to evaluate the difference of other abnormalities (kidney, ureter, bladder, urethra, fistula, other abnormalities) which were binomial data. All analyses were performed with IBM SPSS Statistics for Windows version 20.0 (IBM Corp. Armonk, NY, USA). A p-value <0.05 was considered to indicate a statistically significant difference.

Results

The study group consisted of 248 patients, 157 boys and 91 girls. Median age was 814 days (interquartile range was 2,011 days), and median post-conceptual age was 1,080 days (interquartile range was 2,020 days).

The most common indications were hydronephrosis, detected by other imaging modalities (prenatal ultrasound, postnatal ultrasound) (n = 86) and follow-up known VUR (n = 86), followed by known urinary tract infection (n = 79). The most common underlying condition was spinal dysraphism (n = 12), followed by urinary tract anomalies (n = 6), and multicystic dysplastic kidney (n = 6). Information regarding indications and underlying conditions were shown in Table 1 and 2, respectively.

Mean, median, and mode of DRS were 12.48, 12, and 10 images per examination, respectively (standard deviation = 4.78 images) and those of FCS were 12.78, 12, and 10 images per examination, respectively (standard deviation = 5.78 images). No significant difference of images per examination between FCS and DRS dataset (p = 0.38).

Table 1. Indications for VCUG examination (n = 248)

Indications	Number of patients (%)
Hydronephrosis/hydroureter	86 (34.5)
Follow-up VUR after treatment	86 (34.5)
Urinary tract infection	79 (31.7)
To rule out urinary tract anomaly	55 (22.0)
To rule out VUR	30 (12.0)
Incontinence	4 (1.6)
Urinary tract injury	2 (0.8)

VCUG = voiding cystourethrography; VUR = vesicoureteral reflux

Table 2. Study population's underlying conditions (n = 248)

Underlying conditions	Number of patients (%)
Spinal dysraphism	12 (4.8)
Multicystic dysplastic kidney	6 (2.4)
Double collecting system	6 (2.4)
Double collecting system with ectopic ureterocele	4 (1.6)
Urethral diverticulum	3 (1.2)
Extrophy bladder	3 (1.2)
Caudal regression syndrome	3 (1.2)
Anorectal malformation	3 (1.2)
Horseshoe kidney	2 (0.8)
Posterior urethral valve	2 (0.8)
Ureteropelvic junction obstruction	2 (0.8)
Hypospadias	2 (0.8)
Ectopic ureter	2 (0.8)
Ambiguous genitalia	2 (0.8)
Autosomal recessive polycystic kidney	1 (0.4)
Stricture urethra	1 (0.4)
Ureterocutaneous fistula	1 (0.4)
Epispadias	1 (0.4)
Persistent cloaca	1 (0.4)
Cross fused renal ectopia	1 (0.4)
Prune belly syndrome	1 (0.4)

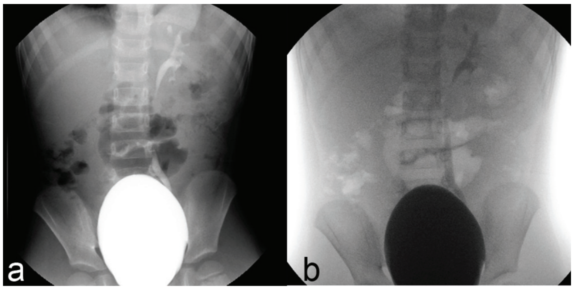

Fig. 1 A 6-year-old boy presented with urinary tract infection. Both DRS image (a) and FCS image (b) show left grade 3 VUR.

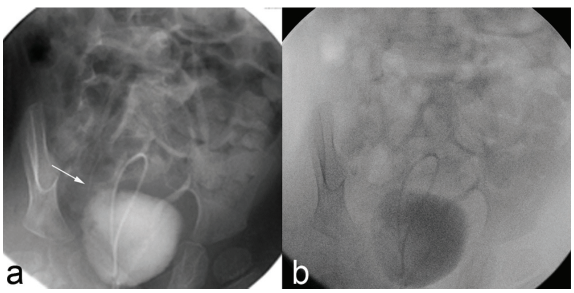

Fig. 2 A 5-year-old girl presented with urinary tract infection. DRS image (a) shows right grade 1 VUR (arrow) while lesion is not visualized on FCS image (b) due to overlying noise.

Kidney abnormalities included hydronephrosis (n = 57), duplex kidney (n = 7), small number of calyx (n = 1), and horseshoe kidney (n = 1). Ureteral abnormalities included hydroureter (n = 62), incomplete double ureter (n = 9), complete double ureter (n = 1), ectopic ureter (n = 2), and post-surgical blind end ureter (n = 2). Bladder abnormalities included neurogenic bladder (n = 22), coarse trabeculation (n = 4), bladder sphincter dyssynergia, (n = 3), paraureteral (hutch) diverticulum (n = 2), irregular bladder wall (n = 2), lobulated bladder contour (n = 2), bladder diverticulum (n = 2), urachal remnant (n = 2), bladder hyperactivity (n = 1), and ureterocele (n = 1). Urethral abnormalities included short urethra (n = 9), posterior urethral valve (n = 3), phimosis (n = 3), anterior urethral diverticulum (n = 2), posterior urethral diverticulum (n = 1), urethral membrane (n = 1), stricture urethra (n = 1), and spin top urethra (n = 1).

There were excellent correlations among three readers (intraclass correlation coefficient (ICC) for detecting VUR, and other abnormalities from FCS were 0.934 and 0.994, respectively, and those from DRS were 0.934 and 0.994, respectively).

There was no significant difference between grade of reflux on DRS and FCS images (*p*-value from the right and left side = 0.194). When VUR characterized as either negative or positive, FCS images perfectly agreed with DRS images.

There were three cases that DRS and FCS showed discrepancies. In the first case, DRS demonstrated right grade 1 VUR while FCS failed to detect the lesion. In the second case, DRS demonstrated right grade 2 VUR while FCS images were indeterminate. The reason for these discrepancies was an effect of image's noise limiting visualization of the lesion. In the third case, FCS failed to demonstrate right grade 2 VUR while DRS did. The reason for this discrepancy was a time gap between DRS and FCS image, not from the difference of image quality (Fig. 4).

The accuracy, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) of FCS images when findings of kidney, ureter, bladder, urethra, fistula detection, and other abnormalities were classified as either negative or positive were 100%.

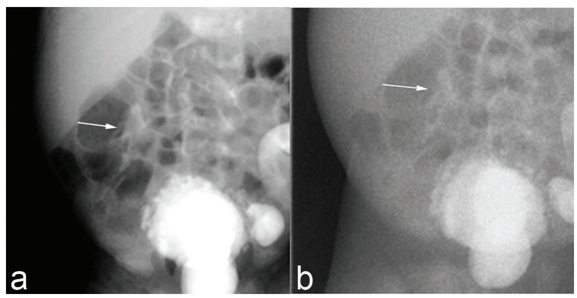

Fig. 3 A 29-day-old male infant with hydronephrosis diagnosed on prenatal ultrasound. DRS image (a) shows grade 2 VUR (arrow in a) while finding on FCS image (b) is indeterminate due to overlying noise.

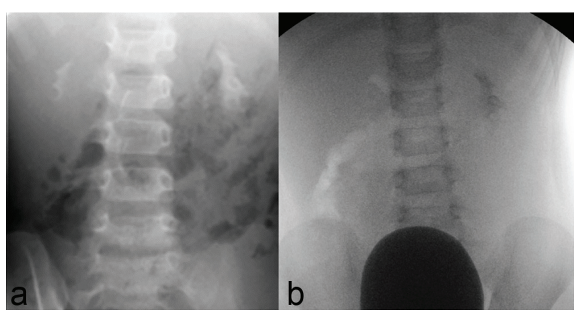

Fig. 4 A 5-year-old boy with known VUR. DRS image (a) shows bilateral grade 2 VUR while FCS image (b) shows only left VUR grade 2. This discrepancy is result from wide time gap between DRS image and FCS image.

When evaluation of VUR by individual grade for each kidney/ureter unit (n = 496), diagnostic accuracy, sensitivity, specificity, PPV, and NPV of FCS in diagnosing negative VUR were 99.7%, 98%, 99.1%, and 99.3% respectively, in diagnosing insignificant VUR (negative or grade 1) were 100%, 96.7%, 98.9%, and 100%, respectively, and in diagnosing low grade VUR (negative or grade 1-2) were 100%, 98.8%, 99.8%, and 100%, respectively.

Sensitivity, specificity, PPV, and NPV stratified by age were shown in Table 3.

Discussion

Children potentially have greater risk from adverse radiation effect than adults do because their tissue are more sensitive to radiation. Due to their long-life expectancy, they are also at risk for radiation-induced malignancy. There are many technologies and techniques associated with fluoroscopic examination used for minimizing radiation exposure such as reducing fluoroscopic time, avoiding using grid, shorten source to skin distance, using pulse fluoroscopy technique, using last image hold[10]. Fefferman et al (2009)[2] found that the radiation exposure from the acquisition of the DRS images in all examination accounted for more than 50% of total exposure. This percentage can be higher when abnormalities are detected during the examination[2]. In the author's experience, radiation exposure increases when the children are uncooperative or take a long time to void spontaneously. Although having lower image quality, image capture technique could minimize radiation exposure during VCUG examination and eliminate radiation exposure from DRS images.

The present study was designed to be a prospective study with the largest sample size to date. Each DRS image in each examination has accompanying FCS image, taken nearly simultaneously, to make the comparison most accurate. This design overcomes the limitation of previous studies which has a potential error related to the inherent time gap between the sequential acquisition of FCS and DRS images. Relatively large sample size in the present study makes assessing the efficacy of FCS images more reliable. The fluoroscopic parameters (matrix, kVp, mAs, and number of pulse per second) were set to lowest available on the fluoroscopic equipment in our department, lower than those in previous studies. In addition to previous studies, the present study also analyzed the value of FCS images for diagnosing non-VUR abnormalities[2,7].

There are two concepts related to stratifying the severity of VUR. First, VUR can be stratified into insignificant (negative or grade 1) or significant reflux. The idea behind this is that it is acceptable to misdiagnose VUR grade 1 to be negative without any adverse outcome. Second, VUR can be stratified into low grade (negative, grade 1-2) or high grade (grade 3-5) according to their management[2].

It is generally accepted that FCS image is noisier and has lower quality than DRS. Most of the radiologists were concerned about possibility of missing subtle pathology (false negative) rather than over diagnosing abnormality (false positive).

O'Connor et al (2004) presented data showing that fluoroscopically captured images could safely replace digital radiographic images for documentation VUR[7]. Fefferman et al (2009)[2] reported overall diagnostic accuracy of FCS in characterizing finding as negative or positive was 97.2%. The sensitivity, specificity, PPV, and NPV for diagnosing the presence of VUR were 96.8%, 98.6%, 95.7%, and 97.7%,

Table 3. Sensitivity, specificity, PPV, NPV according stratified by age

Age	Number of kidney/ ureter unit	Number of positive kidney/ ureter unit	Non reflux/grade 1 reflux vs. grade 2-5 reflux					Number of positive kidney/ ureter unit	Negative/grade 1-2 reflux vs. grade 3-5 reflux				
			Sen (%)	Spec (%)	PPV (%)	NPV (%)	ACC (%)		Sen (%)	Spec (%)	PPV (%)	NPV (%)	ACC (%)
Total	496	226	100	96.6	98.9	100	99.1	248	100	98.8	99.7	100	99.7
Birth to 1 year old	180	158	100	90.0	98.7	100	98.8	166	100	92.8	99.4	100	99.4
>1 to 2 year old	58	13	100	100	100	100	100	11	100	100	100	100	100
>2 to 3 year old	34	9	100	100	100	100	100	9	100	100	100	100	100
>3 to 4 year old	30	14	100	100	100	100	100	16	100	100	100	100	100
>4 to 5 year old	24	7	100	100	100	100	100	6	100	100	100	100	100
>5 year old	170	25	100	100	100	100	100	40	100	100	100	100	100

Sen = sensitivity; Spec = specificity; PPV = positive predictive value; NPV = negative predictive value; ACC = accuracy respectively[2]. When findings characterized as insignificant finding (negative or grade 1), or significant finding (grade 2-5), overall diagnostic accuracy, sensitivity, specificity, PPV, and NPV of FCS images were 94%, 99%, 96.3%, and 98.4%, respectively. When findings characterized as negative/low grade reflux (negative or grade 1-2) or moderate-high reflux (grade 3-5), overall diagnostic specificity, PPV, and NPV of FCS images for the detection of negative/lower grade reflux were 99.1%, 93.9%, and 95.9%, respectively[2]. All results from the present study agreed with those of previous studies. The author concluded that FCS image has low false negative rate in diagnosing and grading VUR.

Most of the discrepancies between DRS and FCS were related to image noise, because the author intentionally set the fluoroscopic protocol to the lowest radiation dose as possible. The lower radiation dose protocols, the noisier images obtained. These noises can obscure visualization of the lesions such as faint contrast in ureter or calyx. Some interventions could be used to overcome these limitations. For example, emptying urinary bladder before starting the examination or using a mixture of saline and water soluble contrast with less dilution or non-dilution. Finally, if image noise is a diagnostic problem, one can manually re-adjust the fluoroscopic protocol to fit the situation best.

The value of FCS images in comparison to DRS was excellent in all ages with slightly lower in the patient age less than one year old (Table 3). This finding indicated that FCS technology can be used with confidence in all pediatric age groups.

Although the present study was designed to overcome limitations of other studies, few minor limitations were inevitable. The present study was performed with a single specific fluoroscopic model. The outcome from this machine model could not directly predict the result from other models. Another limitation relates to the concentration of water soluble contrast media. The present study used fix iodine concentration and dilution ratio of water-soluble contrast agent. With differ contrast agent and dilution ratio, the efficacy of FCS might be different.

Fluoroscopic image capture technology has potential use in the diagnosis of VUR. In the present study, FCS images are adequate for documenting absence/presence of VUR, grading of VUR and urinary tract abnormality on VCUG examination, obviating the need to acquire digital radiographic spot images. This would finally lead to a substantial reduction in the overall radiation exposure during the examination, in accordance with the ALALA principle.

Conclusion

Image from fluoroscopic capture spot technology is sufficient to diagnose VUR and non-VUR urinary tract abnormality on VCUG examination.

What is already known on this topic?

Fluoroscopically captured images are adequate in documenting absence of VUR on VCUG examination, obviating the need for radiographic spot images, and resulting in reduction in radiation exposure.

What this study adds?

This study showed strong evidence that fluoroscopically captured images can replace radiographic spot images in documenting VUR and other KUB abnormalities.

Acknowledgement

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Potential conflicts of interest

None.

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ประสิทธิผลของภาพจากการบันทึกหน้าจอภาพในการประเมินความผิดปกติระหว่างการตรวจภาพรังสีกระเพาะและท่อทางเดินปัสสาวะในผู้ป่วยเด็ก

เกรียงไกร เอี่ยมสวัสดิกุล, พิรา เนื่องตัน, ปรียชาต์ ปาจารย์, จิรวรรธ สุดหล้า, อภิชาติ กล้ากลางชน, เกิดศิริ ธรรมนำสุข, ปิยมาพร วรรณุรักษ์, ยาใจ ไตรสุนทร

วัตถุประสงค์: *เพื่อศึกษาประสิทธิผลของภาพจากการบันทึกหน้าจอในการประเมินความผิดปกติระหว่างการตรวจภาพรังสีกระเพาะและท่อทางเดินปัสสาวะในผู้ป่วยเด็ก*

วัสดุและวิธีการ: *ผู้นิพนธ์ได้ทำการศึกษาไปข้างหน้าโดยศึกษาการตรวจภาพรังสีกระเพาะและท่อทางเดินปัสสาวะในกลุ่มผู้ป่วยเด็ก จำนวน 248 ราย โดยทุกการตรวจนั้นจะมีภาพถ่ายรังสีดิจิทัลและภาพจากการบันทึกหน้าจอภาพที่บันทึกไว้ในระยะเวลาใกล้เคียงกัน เพื่อทำการเปรียบเทียบ ภาพทั้งสองชุดนี้จะมีการนำไปวิเคราะห์แยกจากกันโดยกุมารรังสีแพทย์ 3 คนโดยเน้นการวินิจฉัยภาวะปัสสาวะไหลย้อนจากกระเพาะปัสสาวะสู่ท่อไต ระดับความรุนแรงของภาวะปัสสาวะไหลย้อนจากกระเพาะปัสสาวะสู่ท่อไต ความผิดปกติของไต ท่อไต กระเพาะปัสสาวะ ท่อปัสสาวะ ภาวการณ์รั่วของทางเดินปัสสาวะ และภาวะอื่น ๆ ข้อมูลทั้งหมดจะนำไปวิเคราะห์ถึงประสิทธิผลของภาพจากการบันทึกหน้าจอภาพในการวินิจฉัยภาวะดังกล่าวโดยใช้ภาพถ่ายรังสีดิจิทัลเป็นมาตรฐานอ้างอิง*

ผลการศึกษา: *การศึกษานี้ไม่พบความแตกต่างอย่างมีนัยสำคัญของความสามารถในการวินิจฉัยระดับความรุนแรงของภาวะปัสสาวะไหลย้อนจากกระเพาะปัสสาวะสู่ท่อไตในภาพทั้งสองชนิด สำหรับการวินิจฉัยภาวะผิดปกติของไต ท่อไต กระเพาะปัสสาวะ ท่อปัสสาวะ ภาวะการรั่วซึมของทางเดินปัสสาวะ และภาวะอื่น ๆ พบว่าภาพทั้งสองชนิดให้ผลการวินิจฉัยตรงกันทุกราย เมื่อทำการแบ่งกลุ่มผู้ป่วยออกเป็นกลุ่มผู้มีปัสสาวะไหลย้อนจากกระเพาะปัสสาวะสู่ท่อไตชนิดไม่มีนัยสำคัญ (ผลปกติ หรือ ความรุนแรงระดับ 1) และกลุ่มที่มีภาวะดังกล่าวชนิดมีนัยสำคัญ (ระดับความรุนแรง 2 ถึง 5) พบว่าความแม่นยำ ความไว ความจำเพาะ ค่าพยากรณ์บวก ค่าพยากรณ์ลบของภาพจากการบันทึกหน้าจอในการวินิจฉัยภาวะดังกล่าวชนิดไม่มีนัยสำคัญเท่ากับ ร้อยละ 99.1, 100, 96.6, 98.9, 100 ตามลำดับ และเมื่อทำการแบ่งกลุ่มผู้ป่วยออกเป็นปัสสาวะไหลย้อนจากกระเพาะปัสสาวะสู่ท่อไตชนิดรุนแรงน้อย (ผลปกติ หรือ ความรุนแรงระดับ 1 ถึง 2) และกลุ่มที่มีภาวะดังกล่าวชนิดรุนแรงปานกลางถึงมาก (ระดับความรุนแรง 3 ถึง 5) พบว่าความแม่นยำ ความไว ความจำเพาะ ค่าพยากรณ์บวก ค่าพยากรณ์ลบของภาพจากการบันทึกหน้าจอในการวินิจฉัยภาวะดังกล่าวชนิดรุนแรงน้อยเท่ากับ ร้อยละ 99.7, 100, 98.8, 99.7, 100 ตามลำดับ ทั้งนี้ผลการวิเคราะห์ของภาพทั้ง 2 ประเภท ของกุมารรังสีแพทย์ทั้ง 3 คน มีความสอดคล้องทางสถิติดีมาก*

สรุป: *ภาพจากการบันทึกหน้าจอมีประสิทธิผลดีเท่ากับภาพถ่ายรังสีดิจิทัลในการวินิจฉัยความผิดปกติชนิดต่าง ๆ ในขณะตรวจ ภาพรังสีกระเพาะและท่อทางเดินปัสสาวะในผู้ป่วยเด็ก ในการตรวจทางรังสีดังกล่าวการใช้ภาพจากการบันทึกหน้าจอมีประสิทธิผลเพียงพอต่อการวินิจฉัย*