Comparison of Performance Image Features and Clinical Applications of CR and DR

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***Abstract*—Objective:to compare performance image features and clinical applications of CR and DR. Method:100 CR films and 100 DR films were collected from our department from January 2016 to January 2018, and quality and performance image features of CR and DR films were compared. Results:high quality rate of DR films is 92.00%, higher than that of CR films(81.00%) ($\chi 2=5.181$, $P<0.05$).The waste rate of DR films was 0, lower than that of CR films(3.00%) ($\chi 2=4.120$,$P<0.05$). CR and DR are outputted, stored and recorded in the form of digit. The clinical application scope of CR is wide,and it is flexible to use,with low cost.Spatial resolution of DR is high,radiation quantity of X-ray is low and film shooting speed is fast. Conclusion:both CR and DR own advantages and limitations,and they can supplement each other. In clinical application,it is required to rationally choose them according to their performance image features.**

***Index Terms*—CR; DR; performance image feature; clinical application**

I. Introduction

CR(Computed radiography) and DR (DirectDigit Radiography) are typical radiography techniques which are extensively applied clinically.The two techniques have the advantages of high quality rate of films,fast imaging speed and little radiation,and they represents the trend of photography technology development of radiology department.In this study,performance image features and clinical applications of CR and DR were compared in order to further provide guidance for rational clinical application.

II. Data and Method

A. General data

100 CR films and 100 DR films were collected from our department from January 2016 to January 2018.In CR group,there were 56 male patients and 44 female patients.The age was 18-70,and the average age was 43.6±3.9.The shooting parts included:arms and legs(30 cases),thoracic cavity(25 cases),spine(20 cases),pelvic bone(15 cases)and others(10 cases).In DR group,here were 54 male patients and 46 female patients.The age was 17-68,and the average age was 44.0±4.1.The shooting parts included:arms and legs(29 cases),thoracic cavity(24 cases), spine(22 cases), pelvic bone(14 cases)and others(11 cases).General data of both groups were compared,$P>0.05$.

B. Method

CR film: MUX-10J(Japan Shimadzu)mobile X-ray machine was chosen.The suitable shooting position was adjusted and the parameters were set.The time of exposure was about 3min.the CR images of examination parts were gained through post-processing technology.

DR films:Multix Select(Siemens)DR machine was chosen.The suitable shooting position and photographic methods were adjusted.Manual(or AEC)method was chosen to expose the examination part,with the exposure time of about 3s.DR images of corresponding parts were gained through post-processing technology.

C. Evaluation indicators

The valuation standards follow QA and QC Academic Seminar Summary of National Radiology Department[1]. Grade A:the film position is accurate,and both definition and contrast ratio are good,without artifact and scratch.Grade B:the film position is accurate,and can meet diagnosis demand,but the definition and contrast ratio are insufficient,with artifact.Waste film:the film cannot meet diagnosis demand.High quality rate= number of Grade A films/total number of filmsx100%; waste rate=number of waste films/ total number of filmsx100%.

The performance image features of both techniques were compared, and the indicators included transformation technology, resolution ratio,X-ray dosage, SNR, response speed, environmental requirement, dynamic observation, A/D conversion coefficient, modulation transfer function, cost and detective quantum efficiency.

D. Statistical method

Clinical enumeration data were expressed with %,and processed with SPSS19.0 software.Significance testing was carried out by $\chi 2$.$P<0.05$ means inter-group difference had statistical significance.

III. Results

A. Film quality

High quality rate of CR films was 81.00%(81/100),and the waste rate was 3.00%(3/100).High quality rate of DR films was 92.00%(92/100),and the waste rate was 0.The comparison differences of both groups in high quality rate and waste rate had statistical significance,$P<0.05$,as shown in Table 1.

TABLE I. STATISTICS OF FILM QUALITY IN BOTH GROUPS

Shooting position	CR				DR			
	No.	Grade A	Grade B	Waste film	No.	Grade A	Grade B	Waste film
Arms and legs	30	25	4	1	29	28	2	0
Thoracic cavity	25	21	3	1	24	23	1	1
Spine	20	16	4	0	22	20	2	0
Pelvic bone	15	12	3	0	14	12	2	0
Others	10	8	2	1	11	10	1	0
Total	100	81	16	3	100	92a	8b	0

Note: a.Compared with CR,$\chi 2$=5.181,P=0.031.b.Compared with CR,$\chi 2$=4.120,P=0.043.

B. Comparison of performance image features

Both CR and DR are outputted,stored and recorded in the form of digit,but they have respective advantages and disadvantages in terms of specific performance image features.The clinical application scope of CR is wide,and it is flexible to use,with low cost.Spatial resolution of DR is high,radiation quantity of X-ray is low and film shooting speed is fast,as shown in Table 2.

TABLE II. COMPARISON OF PERFORMANCE IMAGE FEATURES

Performance image indicator	CR	DR
Transformation technology	Indirect	Direct
Resolution ratio(LP/mm)	3.3	3.6
X-ray dose(mAs)	1/2-1/5	Chest 1-3
SNR	Low	High
Response speed	Slow	Fast
Environmental requirement	None	Fixed environment
Dynamic observation	Not support	Support
A/D conversion coefficient	12-16	10-16
Modulation transfer function	Low	High
Cost	Low	High
Detective quantum efficiency(%)	25	50-70

IV. DISCUSSION

CR system and DR system are widely applied clinically and contribute to effective disease diagnosis and curative effect evaluation[2].The advantages of CR technology include spatial resolution,high goodness of fit between signal and real image,good sensitivity and strong recognition capability,etc.The advantages of DR technology include high graph quality,high success rate of exposure and fast imaging speed,etc.In this study,performance image features of CR and DR were compared,in the hope of providing guidance for clinical application.

CR technology mainly applies laser scanning to transform X signal stored on IP of image version into electric signal.Then,digital processing is conducted.Its performance image features include:①own favorable spatial resolution,and be able to imaging finely;② suitable ray density,own good recognition performance [2]; ③ own favorable sensitivity; even weak signal has no obvious adverse impact on imaging; ④ the numerical value acquired by the image well conforms to the real value.In the aspect of clinical application,CR is mainly used for head,neck,chest and abdomen examination [4].During examining chest and abdomen, CR system owns large exposure latitude and strong post-processing capacity(smoothing, splicing, image detail observation and comparison), and can image clearly.During examining head and neck,CR technology can clearly image craniofacial bone fracture,and fracture image of skull line sample can be shown with reinforced frequency,which significantly reduces X-ray exposure [5].

DR mainly passes through human body,and the flat panel detector FP receives X signal.Then,the X signal id directly transformed into digital signal which is inputted in the processing system[6].The performance advantages of DR system mainly include:①good image quality,high definition,high resolution ratio,and distinct layer; ② high success rate of exposure(can reach 100%)[8]; strong post-processing function; ④ the image acquired can be calculated,transmitted,read and stored; ⑤ compatible with PACS system; support telemedicine.DR system is also applicable to head,neck,chest and abdomen examination.During chest and abdomen examination,DR system can highlight the key part through adjustment,and exposure conditions can be chosen to achieve real-time collection,storage and playback[9].

In this study,we compared DR and CR.Seeing from the results,both CR and DR are outputted,stored and recorded in the form of digit.The clinical application scope of CR

is wide,and it is flexible to use,with low cost.Spatial resolution of DR is high,radiation quantity of X-ray is low and film shooting speed is fast.This result basically conforms to the report of Wen Jianwei[10].We also compared the film quality.According to the result,high quality rate of DR films is 92.00%,higher than that of CR films(81.00%)($\chi 2$=5.181,P<0.05).The waste rate of DR films was 0,lower than that of CR films(3.00%)($\chi 2$=4.120,<0.05).Thus,DR owns better image quality,resolution ratio and imaging advantages. CR has the advantages of low cost and application flexibility.CR and DR have certain same points in terms of performance image.For example,both of them can transform X-ray signal into digital signal,and can acquire accurate and clear images,with large exposure latitude.In addition,they can carry out post-processing of images. The two techniques can directly measure distance,size and density.During the measurement,the image quality can be adjusted through window position and window width.Besides,they store the images in the mobile equipment for consultation in other places or secondary consultation.But meanwhile,both own certain limitations. For instance,CR will lead to fuzzy sub-image during X-ray irradiation,so its resolution ratio is lower than that of DR.this will also give rise to fuzzy images.DR requires fixed environmental conditions.

In conclusion,both CR and DR own advantages and limitations,and they can supplement each other.In clinical application,it is required to rationally choose them according to their performance image features.

REFERENCES

[1] Emilio Quaia, Guido Grisi,Elisa Baratella, “Diagnostic imaging costs before and after digital tomosynthesis implementation in patient management after detection of suspected thoracic lesions on chest radiography”, *Insights Imaging*.2014 Feb; 5(1):147–155.

[2] Ślusarczyk-Kacprzyk W, Skrzyński W, Fabiszewska E. “Evaluation of Doses and Image Quality in Mammography with Screen-Film,CR,and DR Detectors- Application of the ACR Phantom”.*Polish Journal of Radiology*,2016,81:386-391.

[3] sz-Lung Ngan, Edward Ting-Hei Wong, Kris Lap-Shun Ng, “The Enhanced Workflow and Efficiency of the Wireless Local Area Network Based Direct Digital Radiography (DDR) Portable Radiography”, *J Digit Imaging*. 2015 Jun; 28(3):302–308.

[4] Yujie W,Jian W. “Clinical and imaging features in different inner border-zone infarct patterns”. *International Journal of Neuroscience*,2015,125(3):208-212.

[5] Gabriela Galateanu, Robert Hermes,Joseph Saragusty, “Rhinoceros Feet Step Out of a Rule-of-Thumb: A Wildlife Imaging Pioneering Approach of Synchronized Computed Tomography-Digital Radiography”. *PLoS One*.2014; 9(6):e100415.

[6] Simpson R,Cutler T E, Danly C R, et al. “Comparison of polystyrene scintillator fiber array and monolithic polystyrene for neutron imaging and radiography”. *Review of Scientific Instruments*,2016,87(11):10D317.

[7] Wen J, Radiology D O. “Comparative Study on the Characteristics and Clinical Applications of CR and DR”[J]. *China Continuing Medical Education*,2016,1(9):10-11.

[8] Carl Berdahl, Jeremiah D.Schuur,Nancy L, “Policy Measures and Reimbursement for Emergency Medical Imaging in the Era of Payment Reform: Proceedings From a Panel Discussion of the 2015 AEM Consensus Conference”, Acad Emerg Med. 2015 Dec; 22(12):1393–1399.

[9] Gabriela Galateanu,Robert Hermes,Joseph Saragusty,The Enhanced Workflow and Efficiency of the Wireless Local Area Network (WLAN)-Based Direct Digital Radiography (DDR)Portable Radiography.J Digit Imaging. 2015 Jun; 28(3):302–308.

[10] Ian D.Honey,Alistair Mackenzie, “Artifacts Found During Quality Assurance Testing of Computed Radiography and Digital Radiography Detectors”.*J Digit Imaging*.2009 Aug; 22(4):383–392.