昭和46年8月25日

Studies on the Effectiveness of a Fluoroscopic Diagnostic Unit of Different Layout of Rooms

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Research field code	Key Words
500	Fluoroscopy, Examination room

透視診断室の能率に関する研究

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（昭和46年5月1日受付）

近年消化管のX線検査例が著しく増加し，少数の放射線科医師でそれを行なうためには時間の無駄をはぶき能率よく検査が行なわれるようにせねばならない．そのために透視診断室の構造，X線装置，人員の配置をいかにすべきかを知らんために藤巻の行なつた検査例 1,521例と吉岡の行なつた463例 について その所要時間を測定して検討した．

使用した6室の構造は第1図，第1表の通りで成績は第2表に示す如くである．藤巻の場合患者入替，造影剤準備などに要する時間（B）を含めて患者1人当りに要した総時間（A）は第2室で最短，次いで第4，第1，第3，第5の順で長くなるが診断に直接関係しない無駄な時間Bの短い程能率 の よいことになり その点では 第1室が最良，次いで第2，第4，第3，第5室の順になる．CはA—Bに当り実際診断に要した時間で，それは診断の難易（使用フィルム枚数Dで推定される）により変化するためその能率はフィルム1枚撮影に要した透視時間（E）（これはフィルム交換，透視台起倒時間などを含む）で比較した．それによると第1室が最短で以下第3，第4，第2，第5室の順となる．これらから透視診断室に隣接した更衣室，フィルム自働交換装置，明るい蛍光像の得られるTV装置が能率向上に有利となる．またフィルム自動交換装置なきときは室内に助手1名を必要とし，助手なきときはバリウム，フィルム交換箱などを手近かに設置する必要がある．多数の透視を行なうためにはX線被曝防止の上から見ても遠隔操作式装置が必要である．

更に第4，第6室で行なつた吉岡の例と比較するにB以外は何れも高値であるがこれは医師により透視診断の方法が異るためであり，設備と能率の関係は前と類似している．

The Aim of These Studies

The efficient performance of fluoroscopy and radiography by the limited number of radiologists is becoming more and more important with the increase in gastrointestinal (especially upper-gastrointestinal) radiography in recent years. It is necessary to avoid waste by saving time in so far as this does not

involve cutting out any of the essentials of the diagnosis. For this purpose, the authors studied the effects of the layout of the room used for fluoroscopy, X-ray equipment, and the presence (or absence) of assistants, on the efficiency of their fluoroscopic and radiographic examinations. The present report deals with some significant results deriving from the authors' studies.

Methods

The following times were investigated in 1521 cases of X-ray examination of the upper gastrointestinal tract which were carried out by Fujimaki from Mar. 1967 to Jan. 1969 and in 463 cases which were examined by Yoshioka from Mar. 1968 to Jan. 1969.

A. The average time taken to examine a patient.

B. The average time to prepare a contrast medium between successive patients.

C. The actural time required for the fluoroscopic examination of a patient; corresponding with A-B.

D. The average number of sheets of X-ray film used for a patient. Note: sets of half- and quarter-plate exposures are counted as 1.5 and 2 sheets of film respectively.

E. The average time required from one exposure or the next exposure.

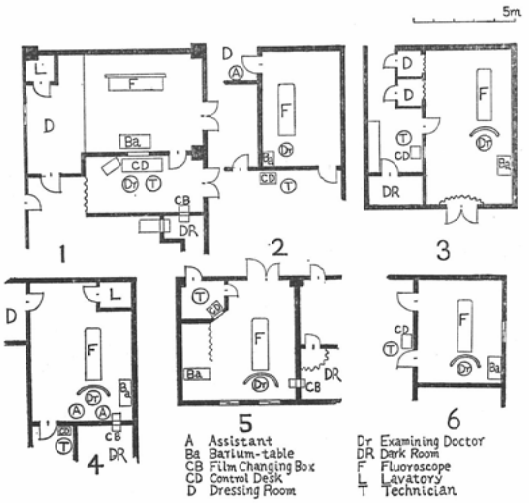

Fig. 1. Layout of each room, used for this study.

The 6 X-ray rooms used for this study are shown in Fig. 1 and Table 1. All X-ray installations are manufactured by one maker and are the same type of equipments except room No. 1.

Results

As shown in Table 2, in the cases dealt with by Fujimaki, 'A' (from 525 to 812 seconds) was the shortest in room No. 2 and became progressively longer in the order of rooms No. 4, 1, 3 and 5. 'B' is wasted time, and the shorter it is, the better the results become. It was the shortest in room No. 1 which had a dressing room and some assistants and it became progressively longer in the order of rooms No. 2, 4, and 3, and was longest in room No. 5 where the physician prepared his own contrast medium, being without

Table 1. X-ray equipments and examiners of each room, used for this study

Room	X-ray equipment	Dressing room	Examinig doctor	Assistant	Technician
No. 1	Remote-controlled televising fluoroscope with automatic film changer	present	Fujimaki	0～2	1～2
No. 2	Fluoroscope with electromotive table	〃	〃	0～1	1
No. 3	〃	〃	〃	0～1	1
No. 4	〃	〃	Fujimaki and Yoshioka	2	1
No. 5	〃	absent	Fujimaki	0	1
No. 6	〃	〃	Yoshioka	0	1

Table 2. Results

Room	Number of patients	A sec.	B sec.	C sec.	D	E sec.	Examining doctor
No. 1	453	584	121	472	7.0	67	Fujimaki
No. 2	86	525	133	413	4.6	90	〃
No. 3	277	655	155	526	6.4	82	〃
No. 4	238	534	139	417	4.6	86	〃
No. 5	467	812	251	608	6.0	102	〃
No. 4	253	956	122	854	7.4	114	Yoshioka
No. 6	210	1150	218	979	7.5	131	〃

A. The total time required in fluoroscopic examination for a patient.
B. The intervals taken between successive patient.
C. The actual time expended in the fluoroscopic examination of a patient.
D. The number of sheets of film used for a patient.
E. The time required from one exposure to the next exposure.

These are all expressed in terms of average values.

both a dressing room and an assistant. 'C', the average time actually required for the fluoroscopic examination of a patient (A-B) was shortest in room No. 2, and became longer in the order of rooms No. 4, 1, and 3, reaching 608 seconds in room No. 5 where the physician himself exchanged X-ray films. 'D', the average number of sheets of film used for a patient, which directly affects the length of 'C', ranged from 4.6 to 7. 'E', the time required from one exposure to the next exposure, averaged 67 to 102 seconds, being the shortest in room No. 1 and becoming progressively longer in the order of rooms No. 3, 4, 2, and 5.

In comparing Fujimaki's results with Yoshioka's in one and the same room (No. 4), the latter was found to take longer for all operations except 'B', when he took 122 seconds as against the former's 139 seconds, as shown in Table 2. Further in respect to Yoshioka's results, all the results in room No. 6 took longer than those of room No. 4.

Discussion

When the time required for fluoroscopic examination is discussed, it is always important to consider the difficulty and the methods of diagnosis. There is considerable difference in the methods of examina-

tion according to the difficulty of diagnosis. In recent years, the tendency to examine the patients at first rather simply by means of a screening test or a routine examination. And if a doubtful feature is observed, the further examination is followed. It is quite natural that a difference will arise between the time required in the first and the second examinations.

In this study the number of sheets of X-ray film used for a patient was considered for this reason. However, it was estimated that the students' going in and out of room No. 5 in pursuit of their studies would somewhat affect the efficiency of the room.

The estimation of the results in each room was as follows:

Room No. 1: 'A', the total time required per patient, was 584 seconds (ranking third). The room was the best equipped, with an under-tube televising fluoroscope fitted with remotecontrolled automatic film changer, but the result 'A' was not so good, 'B', the average interval time between patients was the shortest, being 121 seconds. This was because the patients are prepared for examination in a spacious dressing room adjoining the fluoroscopy room. Therefore, 'C', the actual time required in the fluoroscopic and radiographic examination of a patient, averaged 472 seconds (ranking third next to room No. 2 and 4). This is due to the fact that most patients received scrutiny for abnormal findings which had already been observed by fluororadiography. To this also may be attributed the result that 'D, the number of sheets of film used for one patient, reached an average of 7 and this was the largest of all the cases examined by Fujimaki. However, the time required from one exposure to the next exposure averaged only 67 seconds, being the shortest due to the automatic film changer and the brightness of the fluoroscopic image.

The method of Campbell and Tuddenham, who have reported high efficiencies achieved with remotecontrolled apparatus, seems to require much more time than the method using an automatic film changer, because every time a shot is taken a technician must enter the room and change films and the posture of the patient. The automatic film changer is considered to offer the best prospect of saving time because of its ability to change films without suspending fluoroscopy.

Room No. 2: In this room, 'A' was 525 seconds, and 'C' was 413 seconds (the shortest), which seems to be due to the fact that patients simply underwent examinations akin to routine health examinations and the number of sheets of film used was only 4.6 (the least—as in room No. 4). The interval time between patients averaged 133 seconds, being the shortest after room No. 1. This is due to an adjoining dressing room and an assistant nurse in addition to a technician. However, the time 'E' was next longest after room No. 5, because whenever films are changed, a technician came from the next room and the efficiency was reduced.

Room No. 3: 'A' and 'C' in this room were next longest after room No. 5, being 655 seconds and 526 seconds respectively. This is due to the average number of sheets of film used per patient being 6.4 (including cases requiring detailed scrutiny). However, sometimes a physician was in the fluoroscopy room acting as an assistant and consequently the efficiency of this room was rather high, closely following that of room No. 1, as shown by the fact that the time required from one exposure to the next exposure was 82 seconds. The difference between the values of 'E' for this room and for room No. 2 (the structure of which is not so different from that of room No. 3) seems to be due to the presence of assistants in the fluoroscopy room. The interval time between the successive patients in room No. 3 was 22 seconds longer than

that of room No. 2 (being 133 seconds), because the dressing room cannot be used efficiently, that is, the technician must also lead patients to the dressing room for the lack of an assistant nurse. This can be reduced by improving the method of summoning patients.

Room No. 4: This is similar to room No. 2 in layout, and the results from both rooms were similar while the room No. 4 had one more assistant. This shows that one assistant is enough for a fluoroscopy room and that there is no further increase in the efficiency in respect of time if more assistants are present.

Room No. 5: All the results were the worst in this room. The time 'B' was over twice as long as that of room No. 1, and reached 251 seconds. These are attributed to the following factors. There was no dressing room, so that the former patients must finish dressing before the next one enters into the room. Further, only one physician prepared all the contrast media and injections syringes etc. at the same time. The time required from one exposure to another was long (102 seconds), because the physician himself must change films everytimes, and walk several paces across a spacious room to fetch the contrast media and to reach the film-changing box. Whenever students enter into the room in pursuit of their studies, it causes a further decrease in the efficiency of the fluoroscopic examination.

With the use of one and the same room, No. 4, a considerable difference was shown between the results obtained by Fujimaki and Yoshioka. In the cases dealt with by Yoshioka, 'A' was 956 seconds and 'C' was 854 seconds, and this was longer than Fujimaki. The reasons for this are that the average number of sheets of film used by Yoshioka is 7.4, while Fujimaki used 4.6, only taking 86 seconds of 'E' against Yoshioka's 114 seconds. This time is the sum of time taken in film changing and in fluoroscopy including the operation of a radiographic-fluoroscopic table. The room and the number of staff members were the same, so the difference between the two is thought to have arisen mainly from the difference between actual time spent in fluoroscopy. The differences between the times expended in fluoroscopy vary depending on the difference of difficulty of diagnosis, the condition of the patient (the degree of weakness, the age, etc.) and the physician's line of diagnosis, and it cannot be changed simply. On the other hand, film-changing and operation of the fluoroscopic and radiographic table have nothing to do with the accuracy of diagnosis directly, so they should be reduced as far as possible. When Fujimaki carried out an examination, 'B' was 139 seconds in room No. 4, but was 122 seconds as reported by Yoshioka, and no explanation has yet been found for this.

In the cases of Yoshioka, no difference was observed between the number of films used in rooms No. 4 and 6, but 'E' in room No. 4 was 114 seconds and that in room No. 6 was 131 seconds, possibly through lack of an assistant. The interval time between patients in room No. 6 was 218 seconds, and this suggests that being without a dressing room decreases the efficiency as found with room No. 5.

These results show that the efficiency of fluoroscopic examination is best increased by reducing the interval time between the successive patients. For this, it is necessary to make a dressing room adjoining the fluoroscopy room and to have each ready for examination by the time the former patient has been examined, enabling smooth use of the fluoroscopy facility. Further, it is necessary to reduce the time taken to change films and to operate the fluoroscopic and radiographic table in so far as these have no connection with the accuracy of diagnosis. For this purpose, it is the most effective to use an automatic film changer. Apart from this machine, as the second best method, there should be one assistant in the room for changing

films. When a physician without assistant carries out fluoroscopy, the contrast media and the film-changing box have to be near at hand. In order to reduce the time taken by fluoroscopy, a bright fluorescent image must be obtained, and from this point of view it is advantageous to use the televising fluoroscope.

Further, when only a few physician are available to perform fluoroscopy, a remote-controlled table for diagnosis is good to ensure full protection of the examining doctor against radiation hazard, even though it may be inconvenient to use such a table because of changing postures, palpation and pressure. These were same as already reported by many authors.

Conclusion

The measurement of the time taken was carried out on 1984 cases in 6 fluoroscopy rooms with different layouts in order to raise the efficiency of fluoroscopic examination of the upper gastrointestinal tract. The results obtained from the measurement are shown below. The interval time required between successive patients averaged from 121 seconds to 251 seconds, and this can be reduced by half by the use of a dressing room. The time taken using a fluoroscopic table, or the actual time expended in fluoroscopic examination can be reduced to 67 seconds of the time from one exposure to the next exposure when using the televising fluoroscope with an automatic film changer. By one and the same physician, however, it takes 102 seconds in radiography under unfavorable conditions. In the absence of an automatic film changer one assistant should be present in the room, and if only one physician carries out fluoroscopic examination, contrast media and the film-chaninging box should be close at hand.

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The present study was reported at the meeting of the 28th Japanese Radiol. Society 1969 and was supported by funds supplied by the Shiseikai Institute, Isesaki, Gunma