Teleradiography: Extending the focus film distance

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Lengthened focal film distances reduce the radiation burden to the patient and enhance final film result. Clinicians possessing adequate radiographic equipment are advised to use a minimum FFD of 150 cm (60") and preferably 200 cm (80").

KEY WORDS: Teleradiography, Focus Film Distance, Inverse Square Law.

Des distances focales film allongées permettent de réduire la charge en radiations du patient et améliorent le résultat final sur film. Il est recommandé aux médecins possédant un équipement radiographique adéquat d'utiliser une distance focale film d'un minimum de 150 cm (60") et de préférence de 200 cm (80").

MOTS CLÉS: téléradioagraphie, Distance Focale Film.

It is this author's contention that far too many x-ray films are taken with the radiographic tube situated excessively close to the patient. The objective of this brief paper is to urge chiropractic x-ray clinicians to utilize a lengthened focus film distance (FFD), preferably 200 cms (80"). Improved film quality and decreased radiation issued to the patient are the two major reasons to extend the FFD; the latter reason is emphasized herein.

Historically, short FFDs were utilized by x-ray workers in dealing with patients because of ignorance concerning radiation effects and limitations of generating equipment. In 1938, a chiropractic spinography text[1] advised that the minimum distance from the patient to the tube should be 15 inches; the author went on to say that increasing the distance to 18 inches "eliminates the danger to the patient". Not only was there a lack of understanding of radiation effects in years past, but an unenlightened attitude has persisted amongst many x-ray workers even today. It is not unusual to find radiologists in this group. In an article on leg length in the New Zealand Medical Journal,[2] in 1975, a radiologist shortened the "tube film distance . . . to reduce the patient dosage", whereas in fact, the exact opposite occurred through lessening the FFD.

The inverse square law and radiation

Other considerations remaining constant in producing radiographs of equal density, increasing the FFD always decreases the radiation dose to the patient. X-ray radiation obeys the physical laws of light, including the *Inverse Square Law*. This law states that light intensity is inversely proportional to the square of the distance from the source of the light. In other words, if the FFD is doubled, the intensity of the x-ray beam is quartered. In radiographic terms this means that a film requiring 25mAs at 100 cms (40") will require 100 mAs at 200 cms (80") to yield the same density. At first this amount of mAs may seem excessive. However, remembering the advances made in equipment and the consequent benefits accruing to the patient, lengthy FFDs become quite preferable.

Rather than going through formulae and figures in illustrating radiation savings with the lengthened FFD and the Inverse Square Law, permit me to simplify this fact. From 100 cms (40") a given number of x-ray photons will reach the patient being examined. Some of these photons within the selected Kvp, will be of higher kilovoltage, passing through the patient without interacting. Other photons of lower kilovoltage – often termed "softer" rays – will strike the patient and interact with the cells of the patient. It is these softer photons which are inimical to living beings. Reducing this lower kilovoltage portion of the x-ray beam is a major aim of modern x-ray practice.

Lengthening the focus film distance is central to this objective. Many soft rays of lower kilovoltage which would reach the patient and contribute to the radiation dose at 100 cms (40") simply expire in air and fail to reach the patient at an FFD of 200 cms (80"). Adequate filtration will further reduce softer x-rays. The longer the FFD, and consequent focus patient distance, the less radiation is absorbed by the patient. Less radiation reaches the patient at 150 cms (60") than at 100 cms (40"), even less at 183 cms (72") and at 200 cms (80") and, if films could be taken from 300 cms (10'), given equipment limitations, the patient would benefit even more.

Film density must be maintained equally at all FFDs, and the ISL dictates that more mAs has to be used at greater FFDs. An x-ray beam is not homogenous, it is heterogeneous, containing photons of low kilovoltage and high kilovoltage. As greater mAs is utilized more photons of varying kilovoltage become a part of the beam. With an increased FFD we observe relatively more high kV photons reaching the patient and relatively more low kV photons expiring before they reach the patient and/or the film. This produces a "harder" beam composed of relatively more high kV photons and relatively less low kV photons. It follows that the effective outcome is an improved final film result and a reduced radiation burden to the patient. Jacobi and Pierce[3] conclude that the effect of an increased FFD is to "reduce softer radiation reaching the patient or film, thus controlling x-ray beam quality."

If the clinician uses teleradiographic techniques, for instance FFD of 200 cms (80"), resultant radiographs will have been obtained with less exposure to the patient. Any distance beyond the standard 100 cms (40") will be advantageous. Christensen et al.[4] note that, "as the output of x-ray tubes increases, techniques using up to 60 inch focus film distance may become routine." Not only should 150 cms (60") techniques become commonplace; 183 cms (72") and 200 cms (80") should be utilized whenever the capability of equipment and the building specifications allow.

Image quality

This author has previously affirmed[5] that "professional inertia" is an impediment to extended FFDs. Recall that the horizontally disposed bucky table is a further obstruction to teleradiography. The physical difficulty in elevating an x-ray tube to 200 cms (80") above a recumbent patient creates an impasse for most radiographic departments. On the other hand, the biomechanically sound method of chiropractic x-ray examination in the erect position favors the employment of teleradiography. Most x-ray rooms allow for the tube to be withdrawn 183 cms (72") or 200 cms (80") from the film plane.

Consider the additional benefits of teleradiography: –

1 *Penumbra*. This zone of unsharpness is reduced by a smaller focal spot, a lessened patient-film distance and germane to this discussion, an increased FFD.
2 *Distortion*. An extended FFD assists in minimizing the body-part distortion which occurs at shortened focal film distance
3 *Heel effect*. There is an almost total elimination of the "heel effect" because so much less of the x-ray beam is employed with diagnostic-sized films at lengthened FFDs.
4 *Sharpness*. The FFD is unrelated to radiographic contrast. However, reductions in penumbra, distortion and heel effect lead to enhanced film detail; i.e., improved radiographic sharpness.

Cautionary remarks

Should the clinician struck with radiographic fervour be the possessor of underpowered generating equipment the result could be quite costly. Teleradiography places demands on x-ray machines, demands that are readily met by units of adequate capacity. Remember that 100 mAs at 100 cms (40") translates to 400 mAs at 200 cms (80"). Old inefficient equipment may succumb to overtaxing exertion. Work within the capabilities of your generator and tube. Faster film screen combinations permit longer FFDs.

Radiographic grids are focused at a set distance, e.g., 100 cms (40"), or over a focused range, such as 100 cms-150 cms (40"-60"). For example, if your grid is focused at 40" or 80" you will not be able to take radiographs from 183 cms (72") or 200 cms (80") without experiencing grid cut-off. It is advised that the clinician investigate the grid system in use before employing teleradiographic principles.

Summary

Extending the focus film distance is advantageous in chiropractic spinal roentgenography. The patient always benefits by receiving a lessened radiation burden. In addition, the final film result is invariably enhanced by improved geometric and physical factors. If one's x-ray equipment meets described standards there are no contraindications to the utilization of teleradiography.

References

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