Prospective Evaluation of the Radiologist's Hand Dose in CT-Guided Interventions

Prospektive Evaluation der Handdosis des Radiologen im Rahmen von CT-gestützten Interventionen

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Key words

- radiation effects
- radiation safety
- CT fluoroscopy
- biopsy
- interventional procedures

Abstract

Purpose: Assessment of radiologist's hand dose in CT-guided interventions and determination of influencing factors.

Materials and Methods: The following CT-guided interventions were included: Core biopsy, drainage, periradicular therapy, and celiac plexus neurolysis. The hand dose was measured with an immediately readable dosimeter, the EDD-30 (Unfors, Sweden). The default parameters for CT fluoroscopy were 120 kV, 90 mA and a 4 mm slice thickness. All interventions were performed on a 16-slice CT unit (Aquilion 16 Toshiba, Japan). The tumor size, degree of difficulty (1 – 3), level of experience and device parameters (mAs, dose-length product, scan time) were documented.

Results: 138 CT-guided interventions (biopsy n = 99, drainage n = 23, pain therapy n = 16) at different locations (lung n = 41, retroperitoneum n = 53, liver n = 25, spine n = 19) were included. The lesion size was 4 – 240 mm (median: 23 mm). The fluoroscopy time per intervention was 4.6 – 140.2 s (median: 24.2 s). The measured hand dose ranged from 0.001 – 3.02 mSv (median: 0.22 mSv). The median hand dose for lung puncture (n = 41) was slightly higher (median: 0.32 mSv, p = 0.01) compared to that for the liver, retroperitoneum and other. Besides physical influencing factors, the degree of difficulty (p = 0.001) and summed puncture depth (p = 0.004) correlated significantly with the hand dose.

Conclusion: The median hand dose for different CT-guided interventions was 0.22 mSv. Therefore, the annual hand dose limit would normally only be reached with about 2000 interventions.

Key Points:

- The hand dose exposure during CT fluoroscopically guided interventions was situated on a low level.
- Due to the ambigious radiation risk estimates, additional radiation protection measures/tools should be provided.
- Besides physical parameters, the degree of difficulty and the summed puncture depth had a significant effect on the hand dose.

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Zusammenfassung

Ziel: Ermittlung der Handdosis des Interventionalisten im Rahmen unterschiedlicher computertomografisch (CT-)gestützter Interventionen und Evaluation von Einflussfaktoren.

Material und Methoden: Bei folgenden CT-gestützten Eingriffen wurde die Handdosis mit einem sofort ablesbaren Dosimeter EDD-30 (Unfors, Schweden) ermittelt: Stanzbiopsien, Drainageeinlagen, periradikuläre Therapie sowie Truncus coeliacus Neurolyse. Alle Interventionen wurden an einem 16-Zeilen-CT (Aquilion 16, Toshiba, Japan) in CT-Fluoroskopie-Technik durchgeführt, wobei die Standard-Parameter 120 kV-Röhrenspannung, 90 mA-Röhrenstrom sowie 4 mm-Schichtdicke waren. Es wurden Tumorgröße, Schwierigkeitsgrad (1 – 3), Erfahrungsgrad des Interventionalisten, Nadeldurchmesser und die Geräteparameter (mAs, Dosis-Längen-Produkt sowie die Scanzeit) dokumentiert.

Ergebnisse: In die Auswertung gingen 138 CT-gestützte Interventionen (Lokalisationen: Lunge n = 41, Retroperitoneum n = 53, Leber n = 25 und

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Wirbelsäule n = 19) mit 3 verschiedenen Prozeduren (Biopsien n = 99, Drainagen n = 23 und Schmerztherapien n = 16) ein. Die zu biopsierenden Läsionen hatten eine Größe von 4 – 240 mm (Median 23 mm). Die Fluoroskopiezeit pro Intervention lag zwischen 4,6 und 140,2 s (Median 24,2 s). Die mit dem EDD-30 gemessene Handdosis reichte von 0,001 – 3,02 mSv (Median 0,22 mSv). Die Handdosiswerte für Lungenpunktionen (n = 41) bewegten sich auf einem höheren Niveau (Median 0,32 mSv; p = 0,01) im Vergleich zu Interventionen an Leber, Retroperitoneum und Wirbelsäule. Neben den physikalischen Einflussgrößen zeigten der Schwierigkeitsgrad (p = 0,001) und die summierte Stichtiefe (p = 0,004) einen signifikanten Einfluss auf die Handdosis.

Schlussfolgerung: Bei den evaluierten Eingriffen wurde eine mediane Handexposition von lediglich 0,22 mSv festgestellt, sodass theoretisch über 2000 Interventionen pro Jahr von einer Person durchgeführt werden können, bevor der Handdosis-Grenzwert von 500 mSv erreicht wird.

Introduction

Nowadays, minimally invasive CT-guided interventions play an important role at many institutions and are routinely performed. CT fluoroscopy was first introduced in the clinical routine by Kato and Katada in 1993 [1]. Images can be acquired with real-time control, high geometric precision, and without significant artifacts, resulting in increased accuracy, reduced intervention times, and improved biopsy results [2–6]. However, interventions performed under CT fluoroscopy guidance entail relevant additional radiation exposure for the personnel involved in the intervention. In particular, manipulations performed in the direct beam path of the CT unit can result in significant skin doses for the examiner [4, 7, 8]. CT fluoroscopy-guided interventions are currently a fixture in the clinical routine due to the wide range of possible applications. In the last decades, the interventional possibilities and indications of CT have continued to expand, e. g. to the areas of interstitial brachytherapy and radiofrequency ablation [9–14].

Objective

Due to the increase in CT fluoroscopy-guided interventions and their complexity, it is necessary to conduct a detailed analysis of the radiologist's hand dose exposure. The hand dose range and the risks for the operator must be determined. This raises the following questions: Is the annual hand dose limit of 500 mSv for persons occupationally exposed to radiation reached? Which influencing factors result in a higher hand dose?

Materials and Methods

Patient Data

In the prospective study for examining the radiologist's hand dose, 138 CT-guided interventions involving 131 patients were able to be completed between November 2009 and December 2010. The following interventions were included: CT-guided core biopsy, CT-guided drainage, and CT-guided pain therapy (periradicular therapy and neurolysis/block of the celiac plexus). The study was approved by the Ethics Committee of the Medical Faculty of the Otto-von-Guericke University of Magdeburg.

Inclusion and exclusion criteria for the CT-guided interventions

Inclusion criteria

- All interventions had to be performed on a 16-slice multidetector CT unit (Aquilion 16, Toshiba, Japan) using CT fluoroscopy.
- The preliminary diagnostic CT examination had to show a clearly defined target lesion or target region (in the case of periradicular therapy or celiac plexus neurolysis).
- Re-interventions were possible.
- Interventionalists were required at least 6 months of experience with CT-guided interventions.

Exclusion criteria

- Complex interventions (e. g. CT-guided brachytherapy or radiofrequency ablation),
- puncture of multiple lesions during the same procedure,
- active participation of multiple interventionalists in the puncture procedure,
- misplacement of the EDD-30 sensor or periinterventional shifting of the sensor,
- lack of documentation regarding the needle tip position/drainage system or lack of documentation regarding the contrast agent distribution during interventional pain therapies,
- change of the default slice thickness or tube voltage.

Measurement methods

The hand dose was measured with an immediately readable electronic dosimeter, the EDD-30 (Unfors, Sweden). The detection threshold of the sensor is a dose rate of 10 nGy/s (range: 10 nGy/s – 0.6 mGy/s) [15]. The EDD-30 sensor was attached to the back of the interventionalist's dominant hand. It was positioned between the head of the 2nd and 3rd metacarpal bone (**Fig. 1**).

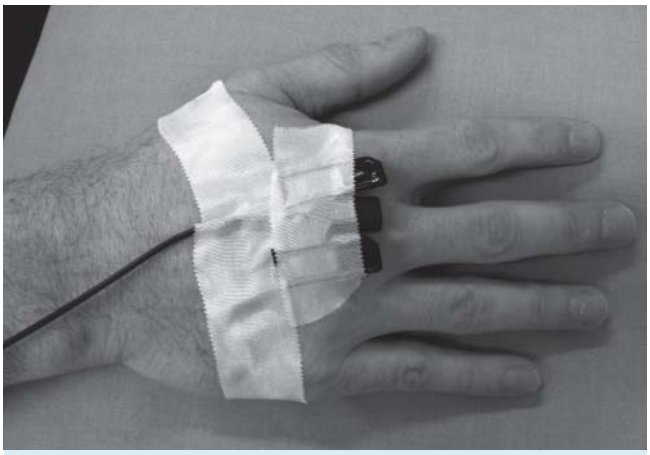

Fig. 1 EDD-30 sensor affixed to the back of the right hand combined with bilaterally affixed TLD plates.

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Validation of the dose measurement via the thermoluminescence detector (TLD) measurement method

In an initial validation study of the hand dosimeter, a simultaneous measurement with TLD plates (Hp 0.07) involving 31 patients was performed. A plate was adhered directly to the right and to the left of the EDD-30 sensor (**Fig. 1**).

Technical parameters

All interventions were performed on a 16-slice CT unit (Aquilion 16, Toshiba, Japan). The default technical parameters for CT fluoroscopy were 120 kV, 90 mA, a 4 mm slice thickness, and a tube rotation time of 0.5 s. In the case of six obese patients (BMI > 30 kg/m²), the tube current intensity had to be increased (to 200 mA for five patients and 300 mA for one patient) due to a decrease in image quality. A combination of discontinuous/intermittent and continuous fluoroscopy was used. Radiation protection gloves were not worn. A standard needle holder (14 cm) was used for 13 retroperitoneal punctures. The following radiation protection measures for the interventionalists were taken: Radiation protection apron with thyroid protection (0.35 mm Pb equivalent), radiation protection glasses, and a lead blanket for the patient.

Recorded parameters

The following variables were documented: Tumor size (anterior-posterior size, width and craniocaudal diameter), location, name of the interventionalist, level of experience, degree of difficulty (1 – 3), body-mass index of the patient, and scan parameters, such as tube current time product (mAs), dose-length product (DLP), and fluoroscopy time.

Moreover, the distance between the skin surface and the needle tip (penetration depth) was measured. In the case of samples being taken multiple times, the distance was multiplied by the number of samples taken (or measured again) and then evaluated as a "summed puncture depth". This was not taken into consideration for punctures using a coaxial needle since the distance to the area to be punctured would not have to be fully covered again.

Classification of the different interventionalists

The eleven interventionalists were classified according to two groups (two different levels of experience):

1. low level of experience (< 5 years of experience with CT fluoroscopy interventions),
2. high level of experience (> 5 years of experience with CT fluoroscopy interventions).

Classification according to degree of difficulty

The interventions were categorized according to three degrees of difficulty with the lesion size and the position in relation to other risk structures being taken into consideration. Two radiologists retrospectively and independently categorized the interventions (based on the acquired CT images) according to three degrees of difficulty. In the case of differences in the degree of difficulty (due to varying reader evaluation), the higher degree of difficulty was used. The classification according to degree of difficulty on a scale of 1 – 3 was based on the following criteria:

1. lesion > 2 cm and risk structures at a distance of > 3 cm in relation to the lesion and the path of the puncture channel,
2. lesion < 2 cm and adjacent risk structures > 2 cm away, angled path of puncture; lung puncture with a distance of > 2 cm from the pleura,
3. lesion < 1 cm in a space orientation and risk structures directly adjacent to or along the puncture channel.

Despite the size of the target area: 5 × 5 × 5 mm³, periradicular therapy was classified as easy (degree of difficulty 1).

Data Analysis and Statistics

A descriptive data analysis was first performed. Since many of the analyzed variables have an asymmetrical distribution, the median and the extreme values were always provided in addition to the mean and standard deviation. Group differences and correlations between the variables were also examined with nonparametric tests. The following statistical methods were used for this purpose: The group differences (different procedures and locations) of the measured hand dose values were analyzed with a Kruskal-Wallis test. To evaluate the influencing factors with respect to the measured hand dose values, a multivariate analysis and a Spearman-Rho rank correlation coefficient test were performed. Univariate variance analyses were used for the simultaneous analysis of degree of difficulty and level of experience with respect to hand dose and fluoroscopy time. The classification of the degree of difficulty by the two readers was checked with a Cohen's Kappa analysis. A significance level of $\alpha = 0.05$ (two-sided) was used for all tests.

Results

The distribution of the 138 CT-guided interventions completed between November 2009 and December 2010 is shown in **Fig. 2**. The median body-mass index of the included patients was 24.7 kg/m² (standard deviation: 7.5 kg/m²).

Comparison of the reference TLD measurements and the EDD-30 measurements

The mean deviation was –7.33 % (95 % tolerance interval for the individual measured value pairs: 0.678 – 1.175). The hand dose measured with the EDD-30 was slightly lower than the doses measured with the TLD.

Dose measurements

The measured hand dose values ranged from 0.001 – 3.02 mSv and the median was 0.22 mSv (mean: 0.315 mSv, standard deviation: 0.391 mSv).

The hand dose median for lung interventions (0.32 mSv; n = 41) was slightly higher than that of interventions in the region of the liver (0.248 mSv; n = 25) and in the retroperitoneum (0.17 mSv; n = 53) and the spine (0.014 mSv; n = 19); (p = 0.01).

The maximum single hand dose value (3.02 mSv) was reached during a retroperitoneal puncture of the pancreas. Without taking the anatomic location into account, the median hand dose value was 0.23 mSv (0.005 – 3.04 mSv) in the biopsy group (n = 99), 0.26 mSv (0.027 – 0.979 mSv) in the drainage group (n = 23), and 0.01 mSv (0.001 – 0.077 mSv) in the pain therapy group (n = 16); (p = 0.011) (**Fig. 3**).

The median fluoroscopy time was 24.2 s (mean: 30.7s; 4.6 – 140.2s; standard deviation: 23.4 s).

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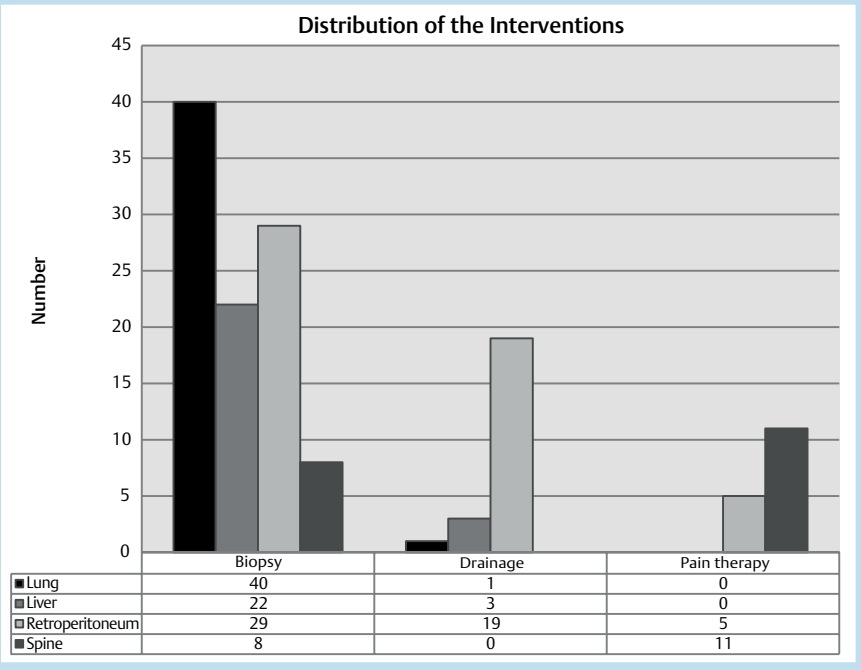

Fig. 2 Distribution of the interventions.

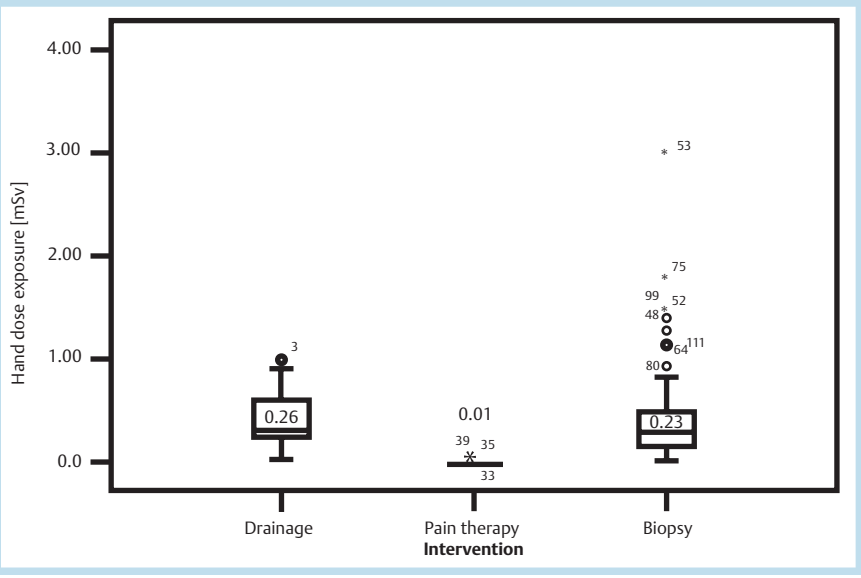

Fig. 3 Different procedures and their hand doses (illustrated median values).

The longest median fluoroscopy time of 32.5 s was reached during liver puncture followed by interventions involving the lungs (25.8 s), retroperitoneum (23.5 s), and spine (17.9 s). The median scan time was 25.5 s (5.6 – 140.2 s) in the biopsy group, 20.2 s (4.6 – 66.4 s) in the drainage group, and 17.7 s (8.8 – 48.3 s) in the pain therapy group; (p = 0.015) (**Fig. 4**).
The mean dose-length product for fluoroscopy was 123.19 mGy×cm (standard deviation: 104.73 mGy×cm).

Classification according to level of experience and degree of difficulty

The experienced interventionalists (level of experience 2) conducted a total of 97 interventions (64 core biopsies, 18 drainages, 11 periradicular therapies, and 4 celiac plexus blocks). In contrast, the inexperienced interventionalists (level of experience 1) only performed 42 interventions (36 core biopsies, 5 drainages, and 1 celiac plexus block). **Fig. 5** shows the classification of the interventions according to the three degrees of difficulty and the level of experience. The interrater reliability for the classification according to degree of difficulty (measure of the agreement between the two radiologists) or the Cohen's kappa value was 0.739 and is therefore to be evaluated as "considerable agreement" [16].

Statistical evaluation of the influencing factors

We used the Spearman-Rho rank order correlation test for the three target variables, hand dose, fluoroscopy time, and dose-length product (DLP), to analyze the influencing factors. The following table shows the correlations of impor-

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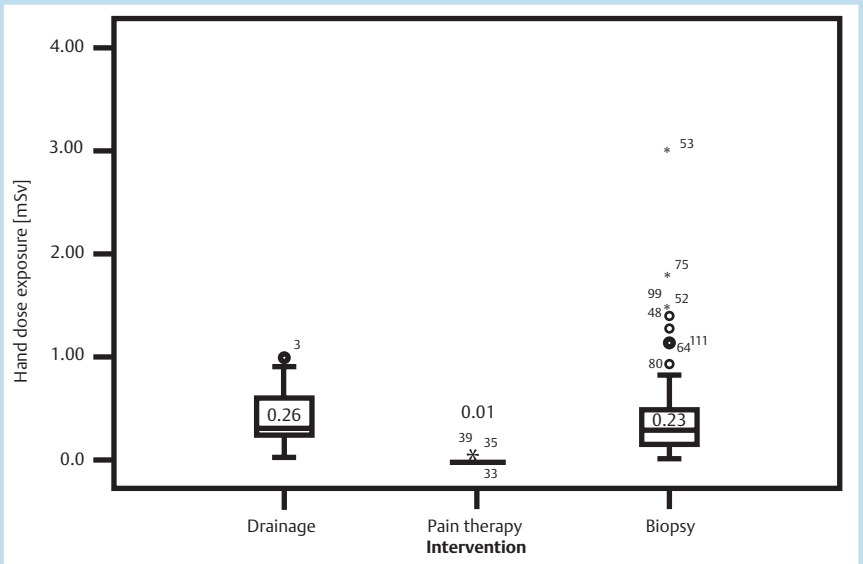

Fig. 4 Different procedures and their fluoroscopy times (illustrated median values).

variable		DLP	fluoroscopy time	hand dose
fluoroscopy time	correlation coefficient	0.923[1]	1.000	0.411[1]
	significance (2-sided)	**0.001**	**0.001**	**0.001**
mAs	correlation coefficient	0.905[1]	0.943[1]	0.418[1]
	significance (2-sided)	**0.001**	**0.001**	**0.001**
degree of difficulty	correlation coefficient	0.329[1]	0.285[1]	0.344[1]
	significance (2-sided)	**0.001**	**0.001**	**0.001**
level of experience	correlation coefficient	– 0.110	– 0.148	0.132
	significance (2-sided)	0.201	0.084	0.123
needle diameter	correlation coefficient	– 0.075	– 0.014	– 0.250[1]
	significance (2-sided)	0.379	0.873	**0.003**
number of punctures	correlation coefficient	0.155	0.186[2]	0.194[2]
	significance (2-sided)	0.069	**0.029**	**0.023**
summed puncture depth	correlation coefficient	0.379[1]	0.342[1]	0.247[1]
	significance (2-sided)	**0.001**	**0.001**	**0.004**

Table 1 Spearman-Rho-Analysis regarding influence factors.

Significant results are in **bold**.
[1] The correlation is significant (two-sided) at α = 0.01.
[2] The correlation is significant (two-sided) at α = 0.05.

tant variables and the associated significance (**Table 1**). The physical relationships of fluoroscopy time, dose-length product, and the mAs product were confirmed with correspondingly strong correlations (r ≥ 0.9). However, the fluoroscopy time and the tube current time product only showed a weak linear relationship to the interventionalist's hand dose (r = 0.411 and r = 0.418; in each case p = 0.01). A high degree of difficulty resulted in a longer fluoroscopy time, a greater dose-length product, and a higher hand dose for the interventionalist (r ≤ 0.344; in each case p = 0.001). The more often a lesion was punctured, the greater the effect on the hand dose and the fluoroscopy time (p = 0.023 and p = 0.029). The needle diameter (needle thickness) showed a significant negative relationship in regard to the hand dose (r = – 0.25; p = 0.003). This can be explained by the fact that thinner biopsy needles were primarily used for lung interventions which resulted in higher hand doses. The number of puncture attempts and the summed puncture depth showed significant but only weak correlations to the fluoroscopy time (p = 0.029; p = 0.001) and hand dose (p = 0.023; p = 0.004) (**Table 1**). In the Spearman-Rho analysis no significant correlation between the level of experience and the hand dose could be shown. A significant correlation also couldn't be shown via two-factor univariate variance analysis of the level of experience and the degree of difficulty (p = 0.946). In the case of an average degree of difficulty (2), the inexperienced interventionalists had a lower average hand dose value (0.313 mSv) compared to the experienced interventionalists (0.345 mSv); p = 0.45, while the opposite was true in the case of easy interventions (degree of difficulty 1) (0.213 vs. 0.165 mSv; p = 0.82). However, the level of experience did have a significant influence with respect to the fluoroscopy time (p = 0.03). The body-mass index resulted in a higher tube current setting in six cases but did not have a significant effect on the hand dose in the analysis (p = 0.308). Multivariate analysis was only able to confirm the tube current time product (p = 0.001), the degree of difficulty (p = 0.004), and the summed puncture depth (p = 0.045) as significant influencing factors on the hand dose. In the biopsy group, the craniocaudal lesion

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size in particular showed the greatest correlation with the hand dose (r = – 0.352; p = 0.001) and the fluoroscopy time (r = – 0.258; p = 0.01). The negative correlations indicate that smaller tumor diameters resulted in a longer fluoroscopy time and a higher hand dose.

Evaluation of the hand dose with respect to the use of a needle holder

The Mann-Whitney test was used to evaluate the reduction in radiation exposure due to the use of a needle holder with a coaxial needle in retroperitoneum interventions. This showed a lower median hand dose value of 0.08 mSv (n = 13) compared to a value of 0.23 mSv (n = 40) without the use of a needle holder. The significance level was almost met with p = 0.052.

Discussion

Hand dose measurements of the TLD versus the EDD-30

A maximum dose rate of 0.6 mGy/s can be recorded with the immediately readable EDD-30 dosimeter, which does not seem particularly high compared to the dose values in the direct beam path (up to 10.4 mGy/s) [15, 17]. For this reason, the 31 simultaneous comparison measurements using TLD plates were performed. However, identical measured values could not be expected due to the test setup since the plates were not in the exact same position as the EDD-30 sensor (**Fig. 1**). The slightly lower measured values can be explained by a directional dependence of the EDD-30 sensor [15]. Other electronic dosimeter models had satisfactory measurement accuracy in clinical use compared to the TLD but the applied dose can be underestimated in the direct beam path [18].

Hand dose values

The hand dose median was 0.22 mSv regardless of the procedure and location. This means that it would take over 2000 CT interventions to reach the annual limit value. In the study by Buls et al. (2003), the median hand dose for the right hand was 0.76 mSv which is significantly higher than our measured values [19]. However, our values were significantly higher than those of Stoeckelhuber et al. (2003) (0.0295 mSv per case) [20]. An explanation for these lower hand dose values is the use of radiation protection gloves and long needle holders. The biopsy needles of our interventionalists were controlled by grasping a side wing of the biopsy system and an angled puncture technique with a "floating CT table" was often used, thus preventing manipulations in the direct beam path. In contrast to these results, the comprehensive dose measurements involving interventionalists' fingers by Pereira et al. (2011) yielded very different results. Despite the additional use of radiation protection gloves, extremely high dose values (up to 36.29 mSv) were measured. It must be mentioned that the TLD measurements were taken at eleven measurement points on the hand (proximal and distal on every finger and on the wrist). Therefore, the proximity to the direct beam path differed greatly from our measurement method [21]. The hand dose values measured at the wrist were lower (0.07 – 0.57 mSv) and comparable to our measurements. Moreover, the back of the hand is usually turned away from the gantry in our measurement, which also explains the lower hand dose values. The substantial variation of the measured hand dose values is consequently dependent on manipulations in the immediate vicinity of the direct beam path and the use of continuous fluoroscopy. In the direct beam path a dose rate of up to 10.4 mGy/s (120 kV, 90 mA) can be expected. This value drops to 27 µGy/s (120 kV, 50 mA) at a distance of 10 cm [17]. Moreover, there is no clearly defined fixed point for hand dose measurements so that there can be significant deviations in the measurements of other authors. More complex interventions, such as CT-guided brachytherapy or radiofrequency ablation, were not included in this study. Higher hand dose values would be expected in these cases.

Influencing factors

In addition to the physical influences to be expected (fluoroscopy time, tube current time product, needle size, lesion size, and summed puncture depth), the degree of difficulty of the intervention could also have a major effect on the hand dose. For the procedures with an easy or average degree of difficulty (biopsy, drainage, and pain therapy), there was surprisingly no significant difference in hand dose between the inexperienced and experience interventionalists. A possible explanation for this could be the greater respect of the inexperienced interventionalists for the direct beam path or their avoidance of continuous fluoroscopy. Furthermore, level of experience 2 as defined by us (> 5 years of experience) could be too high. However, the inexperienced interventionalists needed on average approximately 40 % more scan time even though they only performed one difficult intervention (degree of difficulty 3) (**Fig. 5**).

Biological effect of radiation exposure on the hand

Careless use of X-rays already had significant consequences at the beginning of the X-ray era. Accordingly, radiodermatitis of hands exposed to radiation (so-called "Roentgen hand") was documented for the first time in 1896 [22, 23]. Deterministic radiation effects are not expected in the case of the measured hand doses. Since there is no limit value for the stochastic radiation effect, every X-ray quantum is in principle carcinogenic so that the risk estimate of a chronic suberythemal hand dose is difficult to determine [24, 25]. From the Life Span Study of atomic bomb survivors, an increase in the incidence of basal cell carcinoma due to the additional radiation exposure was able to be confirmed [26, 27]. The hand dose values measured in the present study yielded the following risk estimates (two alternative calculations) on the basis of the ICRP 103 publication [28] and according to Preston et al. [27]: Calculation of the cumulative total hand dose (30 years professional experience): 0.22 mSv (median hand dose per intervention) × 3 (interventions/day) × 250 (work days) × 30 (years) = 4.95 Sv. The nominal risk coefficient for the skin is 670 cases per 10 000 persons per Sv. This results in 4.95 Sv × 0.067 persons/Sv. Consequently, the risk of incidence of "non-melanocytic" skin cancer according to these calculations is 33.1 % (with a very low mortality rate of 0.07 % and a case fatality rate of 0.002 [28]). An alternative calculation according to the relative risk model on the basis of the Life Span Study analysis (based on Table 27 from Preston et al. 2007

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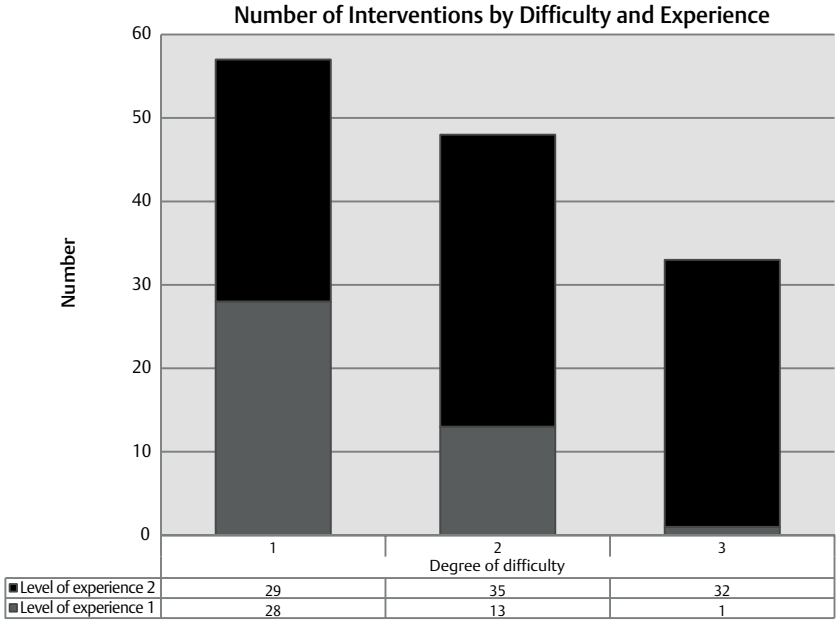

Fig. 5 Distribution of the interventions depending on degree of difficulty and level of experience.

[27]) shows the following: The excess relative risk is 0.17 per Sv resulting in 4.95 Sv × 0.17/Sv = 0.84 as an excess relative risk. This value would have to be multiplied by the lifetime risk of developing basal cell carcinoma (incidence approximately 100 per 100,000 people × 80 years × 0,84 = 7 % [29]). This would therefore result in a lower additional risk compared to the first calculation (7 %; mortality rate: 0.014 %, case fatality rate: 0.004 [27–30]). Despite these calculations of the risk of incidence, the annual hand dose limit of 500 mSv for persons occupationally exposed to radiation was not reduced by the German Commission on Radiological Protection or in the amendment of the X-Ray Ordinance 2011. In the statement of the German Commission on Radiological Protection regarding the topic of "dose limits for occupational skin exposure to ionizing radiation", the above calculations are dismissed and surface personal dose measurement is greatly overestimated [31, 32].

With the following additional radiation protection tools/measures, the hand dose can be greatly minimized: Use of a needle holder, fluoroscopy with low tube current intensity (possibly with incremental adjustment, start thorax: 10 mA; abdomen: 30 mA) or lower tube voltage (≤ 120 kV), low collimation (≤ 4 mm to lower the scattered radiation), restrictive use of continuous fluoroscopy, "angular beam modulation", and, if possible, use of radiation protection gloves [17, 20, 33, 35]. However, radiation protection gloves can give a false sense of security thus resulting in higher hand dose values [35].

Conclusion

An interventionalist would have to perform over 2000 CT interventions (at a hand dose median of 0.22 mSv) to reach the annual hand dose limit value of 500 mSv. In addition to the physical parameters, the summed puncture depth and the degree of difficulty have a significant effect on the hand dose. The estimates regarding the additional radiation risk posed by CT fluoroscopy interventions on the radiologist's hand dose only allow ambigious conclusions. Additional radiation protection measures or tools should therefore be used.

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