Assessment of the Radiation Exposure of Surgeons and Patients During a Lumbar Microdiskectomy and a Cervical Microdiskectomy: A French Prospective Multicenter Study

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OBJECTIVE: **Cervical and lumbar disk herniations are the most frequently carried out procedures in spinal surgery. Often, a few snapshots during the procedure are necessary to validate the level or to position the implant. The objective of this study is to quantitatively estimate the radiation received by a spine surgeon and patient during a low-dose radiation procedure.**

METHODS: **We conducted a prospective multicenter study in France from November 2014 to April 2015. Four spine centers were monitored for radiation received by surgeons during interventions for lumbar disk herniation and cervical disk herniation.**

RESULTS: **A total of 134 patients were included. For lumbar disk herniation, the average exposure for the surgeon was 0.584 μSv on the chest, 5.291 μSv on the lens, and 9.295 μSv on the hands per procedure. For these procedures, the dose area product (DAP) was 94.2 ± 198.4 cGy·cm^2, and the fluoroscopic time was 10.2 ± 16.9 seconds. For a herniated cervical disk, the average exposure for the surgeon was 0.122 μSv on the chest, 3.106 μSv on the lens, and 7.143 μSv on the hands per procedure. For these procedures, the DAP was 35.7 ± 72.1 cGy·cm^2, and the fluoroscopic time was 19.7 ± 13.7 seconds.**

CONCLUSIONS: **Exposure to x-rays for surgeons and patients during surgery for lumbar disk herniation is higher than during surgery for cervical herniation disk. Our results show that radiation exposure to the spine surgeon is still far below the annual dose limits.**

INTRODUCTION

Lumbar disk herniations (LDHs) and cervical disk herniations (CDHs) are pathologies frequently treated. Spine surgeons use fluoroscopy to perform these procedures and to achieve precise surgery and the desired positioning for the spinal implants. These interventions are deemed as low irradiating[1] but very common. There are 33,000 LDH and 10,200 CDH operations each year in France. The repetition of exposure throughout the professional practice of an operator may increase the probability of occurrence of stochastic radiation-induced effects, even at low radiation doses.[2] In recent years, the development of minimally invasive techniques in spinal surgery requires operators to use radiation more frequently. X-ray exposure is thereby significantly increased for patients and operators. The activities in terms of procedure performed by spinal surgeons are often very disparate.

Key words
- Cervical spine
- Intraoperative fluoroscopy
- Lumbar spine
- Radiation exposure
- Radiation safety
- Spinal surgery
- Surgeon

Abbreviations and Acronyms
ACDA: Artificial cervical disk arthroplasty
ACDF: Anterior cervical diskectomy and fusion
BMI: Body mass index
CDH: Cervical disk herniation
DAP: Dose area product
EPD: Electronic personal dosimeter
Hp: Personal dose equivalent
LD: Lumbar diskectomy
LDH: Lumbar disk herniation
TLD: Thermoluminescent dosimeter

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Each operator has their own activity qualitatively and quantitatively. It is essential to know the estimated irradiation per procedure group. For this reason, we conducted a prospective multicenter study in 4 centers of spinal surgery in France to assess the exposure to ionizing radiation during operative procedures using a fluoroscope. This study aims to quantify the radiation received by the surgeon and patient during LDH and CDH.

MATERIALS AND METHODS

Patient Population and Study Design

From November 2014 to April 2015, 134 patients were prospectively enrolled in this study, in 4 different spine centers. Eight experienced surgeons (2 per center) performed the surgeries. Two groups of patients were included. In the first group, the inclusion criteria were the presence of symptomatic LDH treated by posterior lumbar diskectomy (LD), under fluoroscopic guidance. For the second group, the inclusion criteria were the presence of symptomatic CDH treated by anterior cervical diskectomy and fusion (ACDF) and/or artificial cervical disk arthroplasty (ACDA) with placement of an interbody implant, under fluoroscopic guidance. At each center, experienced surgeons performed the interventions.

Interventions for LDH were performed by an open posterior approach, through the interlaminar space. The surgeon performed a resection of the hernia associated with diskectomy without implant placement. Interventions for CDH were performed through an anterior approach with the introduction of an interbody implant.

All procedures were performed using a mobile C-arm x-ray system. The surgeon did not change routine practices for achievement of these procedures. All surgeons wore a leaded protective apron and leaded thyroid protection during the different procedures.

Dosimeters used

Two different dosimeters were used (Figure 1). To evaluate the personal equivalent doses (Hps) to the lens (Dosiris Cristallin [IRSN, Croissy-sur-Seine, France]) and extremities (Bague [IRSN, Croissy-sur-Seine, France]), passive thermoluminescent dosimeters (TLDs) were used. Equivalent lens doses were given at a tissue depth of 3 mm [Hp(3)] and surface dose of extremities at a tissue equivalent depth of 0.07 mm [Hp(0.07)]. The other dosimeter used in that study was an electronic personal dosimeter (EPD). This direct reading dosimeter displayed the Hp at a 10-mm equivalent depth [Hp(10)]. This value is considered a conservative estimate of the effective dose.

Radiation Protocol

For each group of patients (LD or ACDF) and for each center, 2 TLDs were worn by the surgeon: one on the temple on the side of the fluoroscope and one on the third phalanx of the dominant hand's palmar surface. The dosimeter located on the temple estimated equivalent lens dose [Hp(3)], whereas the ring on the finger estimated equivalent dose to extremities [Hp(0.07)]. One EPD was placed on the chest under a lead apron and indicated whole-body irradiation referred to as the effective dose. Only interventions that were studied in our research have been monitored by our dosimeters.

Data Analysis

Data were immediately collected after each procedure through a web-based questionnaire. For each patient, the following data were collected: age, body mass index (BMI), number and level information, type of surgical procedure, and patient's radiation dose. The latter corresponds to the direct measurement of the dose area product (DAP), based on the intraoperatively gathered radiation exposure data and fluoroscopic time. The total operative time was recorded from the start of the incision to the closure. The

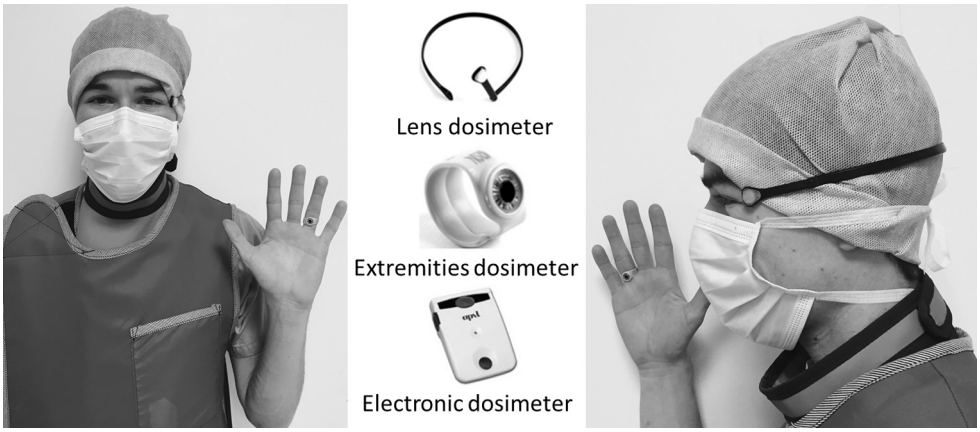

Figure 1. Representation of the different dosimeters used for the study and a diagram representing an operator wearing dosimeters and the proper protective equipment.