통증 및 근골격재활

게시일시 및 장소 : 10 월 18 일(금) 08:30-12:20 Room G(3F)

질의응답 일시 및 장소 : 10 월 18 일(금) 10:28-10:32 Room G(3F)

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## Radiation Exposure of the Physician during C-arm guided Injections and Effectiveness of a New Device

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Does Nonexistence of Your Hands on the Screen Guarantee No Radiation Exposure to Your Body? – Study on Radiation Exposure of the Practitioner during C-arm guided Injections and Effectiveness of a New Shielding Device

**Introduction**

Fluoroscopically assisted medical procedures are performed in many areas including lumbar transforaminal epidural steroid injections (TFESIs) to treat lumbar radiculopathy. C-arm fluoroscopy provides physicians with invaluable images that facilitate precise and effective intervention. However, C-arm exposes physicians to radiation, and the operator's hands are particularly vulnerable to scatter radiation due to long exposure time and short distance from the radiation source.

**Objective**

This study aimed to determine the location of relatively low exposure to scatter radiation, in order to minimize the amount of exposure to the hands of the practitioner during C-arm guided procedures. We also sought to verify the effectiveness of a new, custom-designed shielding device.

**Materials and Methods**

Fluoroscopic examinations were performed on an anthropomorphic phantom model (Figure 1A). The standard C-arm configuration was used. Real-time radiation exposure data were collected using a multi-channel dosimetry system that displays real-time radiation exposure data (RaySafe i2, Unfors RaySafe, Billdal, Sweden) during 10 minutes of continuous use of C-arm fluoroscopy (Figure 1B). Radiation measurement was taken at horizontal distances of 0 cm, 10 cm, 20 cm, and 30 cm from the xiphoid process of the chest phantom, at three angular positions: 0° (L1), 45° (L2), 90° (L3) and three heights: at planes 0 cm (a), 5 cm (b), and 10 cm (c) above the phantom, or above the shielding device (Figure 2A). Measurements were made every 1, 3, 5, and 10 minutes. The same experiment was repeated using a newly designed shielding device. The equipment consists of 2-mm-thick pure lead and 3.2-mm-thick stainless steel, and it is shaped so that practitioners can insert their hands through the hole during procedure (Figure 2B, 2C).

**Results**

Significant radiation accumulation was observed in the field where the practitioner's hands may be placed during C-arm guided procedure. The longer the distance from the radiation resource and the shorter the exposure time, the smaller was the cumulative radiation expose dose (Table 1A). The new shielding device showed an excellent shielding rate (66.0–99.9%) when the dosimeter was within the shielding range (Table 1B).

**Discussion**

C-arm fluoroscopy-guided procedures involve a marked risk of radiation exposure of the hands. In order to reduce the radiation, it is necessary to reduce the exposure time during the procedure and to keep an appropriate distance from the radiation resource. When using a shielding device such as the one we designed, keep the hands as close as possible to the device surface, remain within the device's shielding range, and perform fluoroscopy as rapidly as possible.

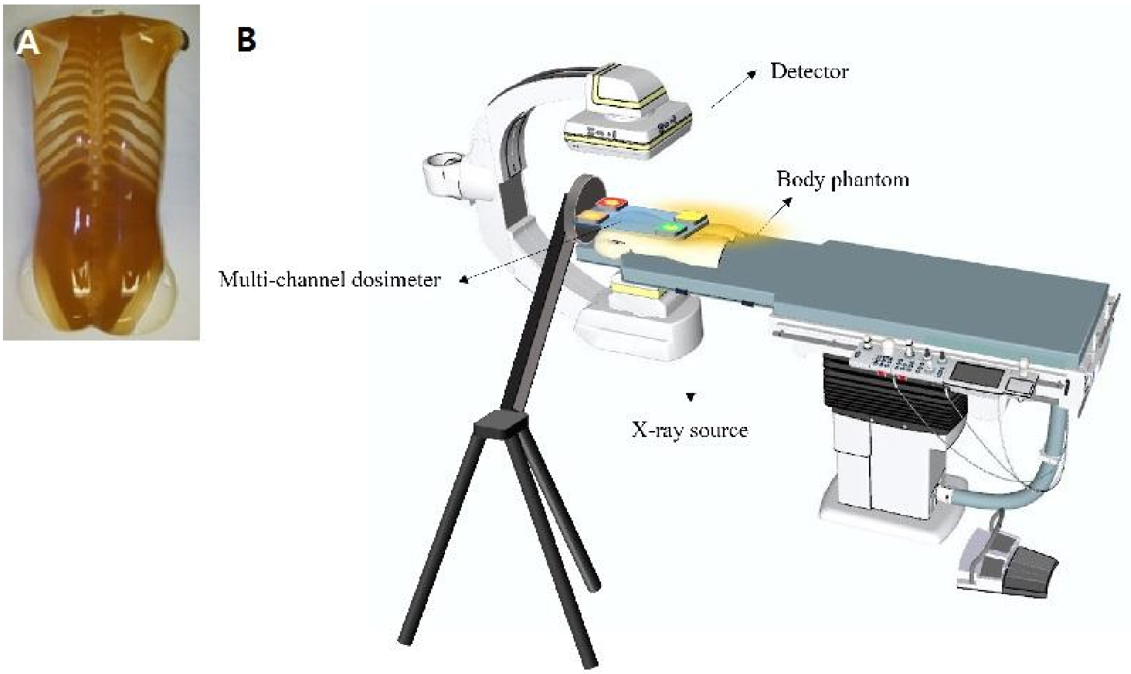


fig. 1 (A) Chest phantom composed of human bones surrounded by acrylic with approximately the same density as human soft tissue, (B) The chest phantom was laid on the operating table 50 cm above the X-ray tube. Using a chest phantom irradiated with X-rays under lumbar TFESI conditions, cumulative scatter radiation dose was measured every 1, 3, 5, 10 minutes at 36 points, using a dosimeter.

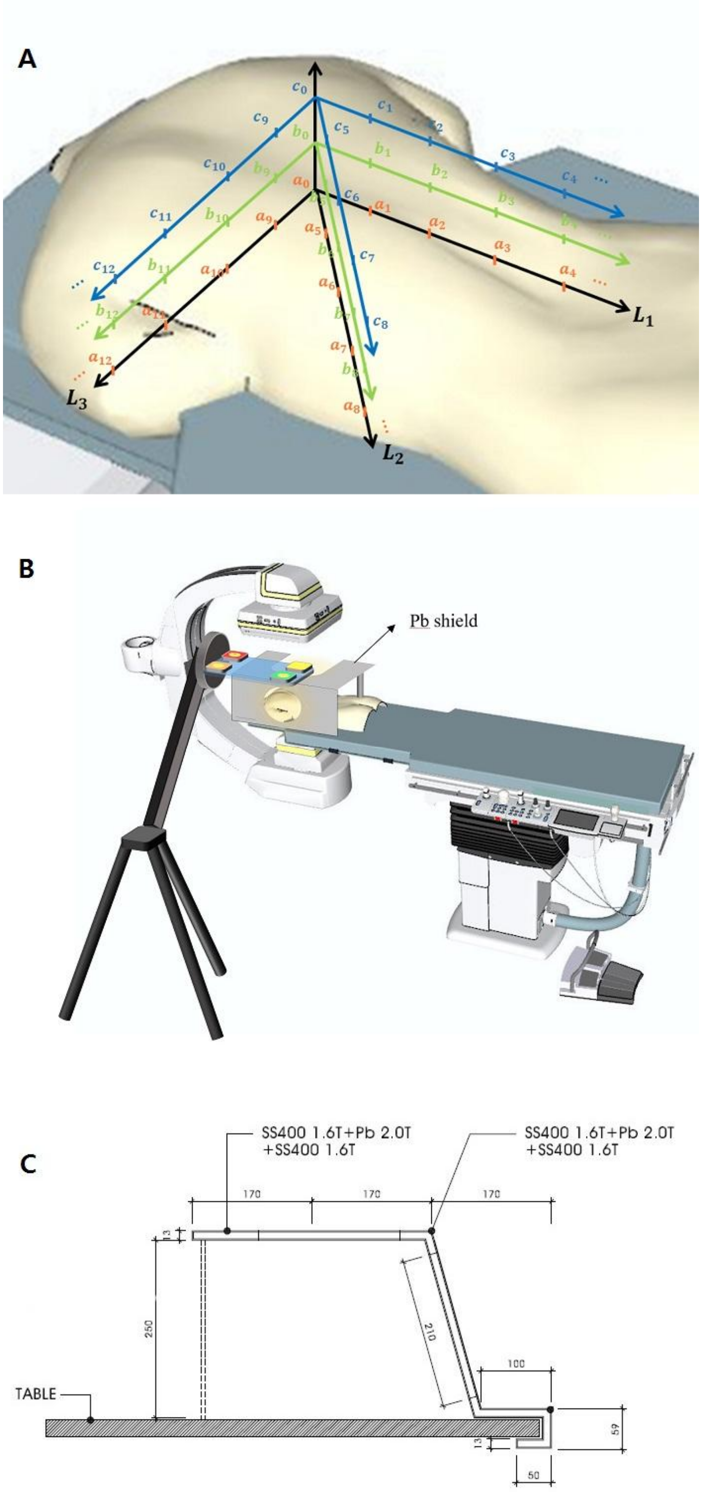


fig. 2 (A) A photographic depiction of the measurement points, (B) The relationship between the chest phantom, shielding device, and the C-arm controller, (C) Side view of the shielding device.

**(A)**

| Dosimeter placement | | Exposure(μSv) 1 min | 3 min | 5 min | 10 min |
|---|---|---|---|---|---|
| "a" plane | | | | | |
| L1 | a1 | 223.3 | 622.7 | 1015.8 | 2031.2 |
| | a2 | 198.2 | 546.2 | 889.6 | 1780.4 |
| | a3 | 86.6 | 235.9 | 389.1 | 764.3 |
| | a4 | 45.5 | 129.5 | 212.0 | 418.4 |
| L2 | a5 | 220.0 | 615.1 | 1026.9 | 2177.4 |
| | a6 | 160.4 | 456.3 | 760.8 | 1512.2 |
| | a7 | 59.6 | 165.7 | 275.6 | 550.2 |
| | a8 | 36.6 | 102.3 | 170.7 | 339.9 |
| L3 | a9 | 254.1 | 756.7 | 1257.7 | 2511.6 |
| | a10 | 215.1 | 643.2 | 1069.8 | 2130.5 |
| | a11 | 145.5 | 429.5 | 715.2 | 1423.4 |
| | a12 | 82.7 | 246.2 | 411.4 | 821.1 |
| "b" plane | | | | | |
| L1 | b1 | 213.1 | 612.3 | 1007.4 | 2014.4 |
| | b2 | 145.3 | 436.4 | 726.8 | 1425.5 |
| | b3 | 77.0 | 229.8 | 382.5 | 766.2 |
| | b4 | 44.9 | 125.4 | 202.3 | 408.1 |
| L2 | b5 | 205.8 | 584.6 | 1020.1 | 2169.9 |
| | b6 | 145.0 | 414.9 | 712.1 | 1401.3 |
| | b7 | 50.3 | 152.1 | 268.3 | 504.1 |
| | b8 | 26.7 | 77.9 | 157.7 | 300.2 |
| L3 | b9 | 198.3 | 588.5 | 977.7 | 1988.1 |
| | b10 | 159.8 | 488.1 | 793.8 | 1554.3 |
| | b11 | 106.1 | 313.6 | 512.6 | 1024.6 |
| | b12 | 69.5 | 205.7 | 342.6 | 684.2 |
| "c" plane | | | | | |
| L1 | c1 | 211.8 | 610.1 | 1002.1 | 2015.0 |
| | c2 | 123.3 | 367.9 | 620.1 | 1238.1 |
| | c3 | 73.7 | 221.0 | 372.4 | 741.2 |
| | c4 | 44.3 | 129.1 | 211.9 | 412.8 |
| L2 | c5 | 165.7 | 491.8 | 814.8 | 1644.2 |
| | c6 | 110.0 | 328.3 | 542.9 | 1079.8 |
| | c7 | 52.1 | 159.3 | 274.1 | 545.7 |
| | c8 | 33.1 | 101.5 | 171.0 | 335.5 |
| L3 | c9 | 224.7 | 666.3 | 1106.1 | 2201.1 |
| | c10 | 160.2 | 478.0 | 801.8 | 1594.8 |
| | c11 | 108.0 | 316.0 | 525.1 | 1045.5 |
| | c12 | 80.9 | 238.7 | 396.3 | 790.1 |

**(B)**

| Dosimeter placement | | Exposure(μSv) 1 min | 3 min | 5 min | 10 min |
|---|---|---|---|---|---|
| "a" plane | | | | | |
| L1 | a1 | 1.9 | 4.3 | 6.7 | 12.5 |
| | a2 | 0.5 | 1.8 | 1.8 | 2.3 |
| | a3 | 108.3 | 328.0 | 549.0 | 1093.2 |
| | a4 | 67.7 | 198.2 | 331.7 | 660.2 |
| L2 | a5 | 2.9 | 8.0 | 13.1 | 23.3 |
| | a6 | 0.7 | 2.0 | 3.2 | 6.0 |
| | a7 | 2.5 | 8.1 | 13.6 | 25.1 |
| | a8 | 6.0 | 16.7 | 27.5 | 52.4 |
| L3 | a9 | 0.7 | 2.9 | 5.1 | 11.0 |
| | a10 | 135.7 | 404.6 | 675.1 | 1339.5 |
| | a11 | 106.2 | 315.1 | 526.8 | 1048.7 |
| | a12 | 37.5 | 112.2 | 187.5 | 372.4 |
| "b" plane | | | | | |
| L1 | b1 | 1.1 | 3.2 | 5.5 | 10.0 |
| | b2 | 0.5 | 1.5 | 2.7 | 5.1 |
| | b3 | 101.1 | 308.2 | 514.2 | 1025.4 |
| | b4 | 59.3 | 177.3 | 296.6 | 589.9 |
| L2 | b5 | 1.2 | 2.8 | 4.8 | 9.9 |
| | b6 | 0.4 | 1.2 | 2.1 | 3.9 |
| | b7 | 1.0 | 3.9 | 7.5 | 15.0 |
| | b8 | 5.0 | 14.6 | 24.7 | 47.6 |
| L3 | b9 | 1.1 | 3.1 | 5.2 | 11.2 |
| | b10 | 119.2 | 357.6 | 599.1 | 1187.6 |
| | b11 | 85.6 | 258.5 | 421.9 | 836.3 |
| | b12 | 27.6 | 82.8 | 137.7 | 262.5 |
| "c" plane | | | | | |
| L1 | c1 | 18.9 | 57.2 | 95.1 | 201.2 |
| | c2 | 0.9 | 2.8 | 5.0 | 9.8 |
| | c3 | 20.3 | 62.5 | 105.2 | 206.4 |
| | c4 | 53.6 | 163.7 | 272.5 | 539.7 |
| L2 | c5 | 32.1 | 0.8 | 3.5 | 30.4 |
| | c6 | 0.8 | 2.4 | 3.9 | 7.1 |
| | c7 | 3.5 | 9.6 | 15.8 | 29.9 |
| | c8 | 30.4 | 92.8 | 154.3 | 302.7 |
| L3 | c9 | 75.0 | 220.5 | 362.5 | 748.9 |
| | c10 | 89.1 | 275.4 | 458.0 | 913.6 |
| | c11 | 91.7 | 273.9 | 454.4 | 906.9 |
| | c12 | 39.2 | 117.9 | 195.8 | 388.8 |

fig. 3 (A) Radiation exposure dose at different points, without use of shielding device, (B) Radiation exposure dose at different points with device