

FRACTURES OF THE DISTAL EXTREMITY OF THE TIBIA TREATED WITH INTRAMEDULLARY NAIL OR BRIDGE PLATE: COMPARISON OF RADIATION EXPOSURE DURATION BETWEEN THE TWO METHODS

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ABSTRACT

Objective: To compare the duration of exposure to radiation among patients with fractures of the distal third of the tibia treated with an intramedullary nail or with a bridge plate. **Methods:** Intramedullary nails were used for 33 fractures, and bridge plates were used for 41 fractures. In the nail group, according to the AO classification, 14 patients had type A fractures, 15 had type B and four had type C. Twelve patients had closed fractures and 21 had open fractures. In the plate group, 10 patients had type A fractures, 22 had type B and nine had type C. Twenty-seven patients had closed fractures and 14 had open fractures. **Results:** There was a significant difference in the duration of exposure to radiation between the patients treated using a nail

and those treated using a plate ($p = 0.0001$). The group treated using a nail had significantly greater exposure to radiation than did the group treated using a plate. Comparing the type of fracture (A, B or C), it was observed that there was no significant difference in the duration of exposure to radiation between the nail technique ($p = 0.19$) and the plate technique ($p = 0.80$). **Conclusion:** Fractures of the distal third of the tibia treated with an intramedullary nail present significantly greater exposure to radiation than do fractures treated with a bridge plate, independent of the fracture type.

Keywords – Tibial fractures; Fracture fixation, intramedullary; Radiation exposure; Comparative study

INTRODUCTION

The radiation risks to which certain specialists are exposed, including radiologists cardiologists and oncologists, have already been well documented⁽¹⁾. However, despite the increasing use of image intensifiers in orthopedic surgery, few studies have assessed the radiations risks among such surgical teams.

Over the last 20 years, with the introduction of new orthopedic procedures such as intramedullary fixation using locked nails in long bones, fixation using pedicle screws in the spine and minimally invasive procedures, the use of image intensifiers has increased. These procedures may involve prolonged exposure to radiation among the orthopedic surgeons and other professionals who work in the surgical center. Mehlman and

DiPasquale⁽²⁾ demonstrated that, depending on the distance between the fluoroscopy ampoule and the surgeon, this person might receive a significant quantity of radiation exposure. Such exposure could occur particularly in the eyes, leading to the development of cataracts; in the thyroid, leading to the formation of sarcomas; and in the hands.

The aim of the present study was to compare simply the duration of radiation exposure during treatments for fractures of the distal third of the tibia, between the use of the techniques of intramedullary locked nails and bridge plates. This becomes an important matter, since the relationship with the treatment technique may, over the medium and long terms, influenced the appearance of irreversible lesions in orthopedic surgeons.

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METHODS

Between January 2006 and December 2007, 74 cases of fractures of the distal third of the tibia were treated at Hospital Santa Teresa, in Petrópolis, RJ. For 33 fractures, the present authors used intramedullary locked nails (non-milled Baumer® or universal AO®), and for 41 fractures, they used bridge plates for wide or narrow dynamic compression (AO®), depending mainly on the bone size.

The inclusion factors for this study were that the patients should have fractures of the distal third of the tibia that were treated with intramedullary locked nails or bridge plates. The operations were performed in the surgical center of Hospital Santa Teresa, with the same surgical equipment and a team that had been trained in the use of two image intensifier devices (GE® model G045 and Siemens® model G5429), which supplied the radiation during the procedures. The procedures were performed by two surgeons, each with more than ten years of experience. Our study did not evaluate the level of radiation but just its duration.

Among the patients treated using intramedullary nails, 26 were male and seven were female. The patients' ages ranged from 17 to 54 years (mean of 33.1 years). The AO classification (*Arbeitsgemeinschaft für Osteosynthesfragen*)⁽³⁾ was used to divide the fractures of the tibial diaphysis into three types according to the degree of contact between the main fragment after reduction. Among these patients, 14 presented type A fractures, 15 had type B, four had type C and 12 had closed fractures. The exposed fractures were classified in accordance with Gustilo and Anderson⁽⁴⁾, who divided the exposed fractures into three grades. There were seven grade I fractures, ten grade II and four grade III.

Among the patients treated with bridge plates, 34 were male and seven were female. The patients' ages ranged from 14 to 76 years, with a mean of 30.8 years. With regard to the AO fracture classification, 10 were type A, 22 were type B and nine were type C. In the group of exposed fractures, three were grade I, six were grade II and five were grade III A. Twenty-seven patients presented closed fractures.

Table 1 presents the frequencies and percentages from the AO classification according to the technique used (nail or plate). It was found using the chi-square test that there was no significant association ($p = 0.21$) between the type of fracture and the technique. It was noted that the more severe types of fracture (B and C) were treated more often using the plate technique, but without reaching statistical significance.

Table 1 – AO classification versus technique

AO type	Technique		
	Nail	Plate	Total
A	14 42.42	10 24.39	24
B	15 45.45	22 53.66	37
C	4 12.12	9 21.95	13
Total	33	41	74

Statistical methodology

Statistical analysis was performed using the Mann-Whitney test to investigate whether there was any difference in the duration of exposure to radiation (in seconds) between the two techniques (nail and plate). To make comparisons between the three types of AO classification (A, B and C), Kruskal-Wallis analysis of variance was performed.

Nonparametric methods were used, since the duration of intensifier use did not present normal (Gaussian) distribution, because of data dispersion and lack of symmetry of the distribution. The criterion used to determine significance was a level of 5%.

RESULTS

Table 2 presents the mean, standard deviation (SD), median, minimum and maximum for the duration of intensifier use (in seconds), according to the group (nail or plate). The analysis was performed using the Mann-Whitney test.

Table 2 – Statistical analysis on the duration of intensifier use (in seconds), according to the technique

Technique	n	Mean	SD	Median	Minimum	Maximum	p
Nail	33	129.1	44.8	120	60	270	0.0001
Plate	41	68.5	36.4	60	18	160	

Source: Hospital Santa Teresa, Petrópolis, RJ, 2007
SD: standard deviation

It was observed that there was a significant difference in the duration of exposure to radiation between the use of nails and plates ($p = 0.0001$). The group treated using nails presented significantly greater duration of exposure to radiation than did the group treated using plates.

To show whether there was any relationship between the duration of exposure to radiation and the severity of the fractures, Tables 3 and 4 present the mean, standard deviation (SD), median, minimum and maximum of the duration of exposure to radiation (in seconds), according to the AO classification (A, B and C), for the nail and plate techniques, respectively. The analysis was performed using Kruskal-Wallis ANOVA.

Table 3 – Statistical analysis on the duration of intensifier use (in seconds), according to the AO classification, for the nail technique

Type	n	Mean	SD	Median	Minimum	Maximum	p
A	14	122.2	52.1	118	60	270	0.19
B	15	134.0	44.0	120	70	230	
C	4	135.0	12.9	135	120	150	

Source: Hospital Santa Teresa, Petrópolis, RJ, 2007
SD: standard deviation

Table 4 – Statistical analysis on the duration of intensifier use (in seconds), according to the AO classification, for the plate technique

Type	n	Mean	SD	Median	Minimum	Maximum	p
A	10	62.0	40.4	60	18	160	0.80
B	22	69.1	33.1	65	18	120	
C	9	74.0	42.6	54	30	140	

Source: Hospital Santa Teresa, Petrópolis, RJ, 2007
SD: standard deviation

It was observed that there was no significant difference in the duration of exposure to radiation between types A, B and C ($p = 0.19$) when the nail technique was used.

It was observed that there was no significant difference in the duration of exposure to radiation between types A, B and C ($p = 0.80$) when the plate technique was used.

Tables 5 and 6 present the mean, standard deviation (SD), median, minimum and maximum of the duration of exposure to radiation (in seconds), according to the AO classification (A and B + C), for the nail and plate techniques, respectively. This analysis was performed using the Mann-Whitney test. The aim of this analysis was to separate the simple fractures from the more complex fractures, and for this, types B and C in the AO classification were grouped together in order to obtain greater power for the statistical test.

Although there was no significant difference at the 5% level, we were able to see a tendency ($p = 0.085$) for the fractures that were more severe (B + C) to present

Table 5 – Statistical analysis on the duration of intensifier use (in seconds), according to the AO classification, for the nail technique

Type	n	Mean	SD	Median	Minimum	Maximum	p
A	14	122.2	52.1	118	60	270	0.085
B + C	19	134.2	39.2	130	70	230	

Source: Hospital Santa Teresa, Petrópolis, RJ, 2007
SD: standard deviation

greater duration of exposure to radiation than that of the type A fractures, with regard to the nail technique.

Table 6 – Statistical analysis on the duration of intensifier use (in seconds), according to the AO classification, for the plate technique

Type	n	Mean	SD	Median	Minimum	Maximum	p
A	10	62.0	40.4	60	18	160	0.51
B + C	31	70.5	35.4	60	18	140	

Source: Hospital Santa Teresa, Petrópolis, RJ, 2007
SD: standard deviation

It was observed that there was no significant difference in the duration of exposure to radiation between the fracture types ($p = 0.51$) when the plate technique was used. In this case, there was no tendency towards increased duration of exposure to radiation between the different types of fracture.

DISCUSSION

The risk caused by intraoperative radiation continues to be a widely discussed topic, especially with the development of orthopedic procedures that use image intensifiers⁽⁵⁻¹¹⁾. The quantity of exposure to radiation for patients is acceptable and remains within the safety margins^(12,13). However, for surgeons and other professionals who work in surgical centers, the duration of exposure may be significant and have uncertain consequences⁽¹⁴⁾. The worry in relation to using image intensifiers is the possibility of malignancy. The areas in question include the eyes (lenses), neck region (thyroid), organs (liver and spleen), gonads and hands (skin)⁽⁹⁾.

Giachino and Cheng⁽¹⁵⁾ measured the diffusion of radiation to which orthopedic surgeons were exposed during the procedure to treat fractures of the femoral neck. They found that when the surgeon was positioned at least 46 cm from the greater trochanter, the exposure to radiation was greatly reduced. Dosch *et al*⁽¹⁶⁾ measured the relationship between the radiation registered

in the surgical room during the intramedullary locked nail procedure and the distance of the radiation ampoule from the patient. Sanders *et al*⁽⁹⁾ analyzed the exposure to radiation during insertion of intramedullary nails into the femur and tibia. Because of greater muscle mass, the femur was associated with greater diffusion of radiation than the tibia was. This was because the tibia is smaller than the femur, the bone location is subcutaneous and it is easier to reduce this bone and insert the locking screws. According to Sanders *et al*⁽⁹⁾, insertion of intramedullary screws required significantly greater duration of fluoroscopy (mean duration of 3.6 minutes) than was required for other types of procedure (mean duration of 2.1 minutes). In our study, among the entire sample, comparing the duration of exposure to radiation between the nails and plates, the nails presented a mean duration of radiation (129.1 seconds) that was significantly greater than that of the plates (68.5 seconds).

In the present study, the tibial fractures treated were in the distal third in both groups. For the fractures treated using intramedullary locked nails, the locking consisted of two proximal screws and two distal screws, while for the plates, there were three proximal and three distal screws. We observed that there was a significant difference in the duration of exposure to radiation when we treated the tibial fractures using intramedullary locked nails, as also demonstrated in the literature^(9,11,17-21). It should be noted that, in comparing the duration of radiation

between the nails and plates used for fractures of the distal third of the tibia, the nails presented greater duration of radiation than that of the plates because of the need to find the ideal entry point for introducing them into the proximal region and for the distal blocking, which was done freehand. Krettek *et al*⁽¹¹⁾ diminished the duration of exposure to radiation by using a distal fixation device (DAD) for the distal region, thereby decreasing the duration of radiation.

In using the AO fracture classification to investigate whether the type of fracture would influence the duration of exposure to radiation, there was no significant difference between the nail and plate groups. In the groups that was treated using intramedullary nails, a tendency towards occurrences of greater radiation with the fracture types of greater severity (B and C), but this was not observed in the group of fractures that were treated using bridge plates. We did not find any studies in the literature (PubMed) that compared the duration of exposure between intramedullary nails and bridge plates, with regard to distal fractures of the tibia.

CONCLUSION

We conclude that the duration of exposure to radiation was significantly greater when using intramedullary locked nails than it was when using bridge plates, for treating fractures of the distal third of the tibia, independent of the type of fracture.

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