

# Minimizing Radiation Dose in Metallic Foreign Body Screening of the Orbits Prior to Magnetic Resonance Imaging

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## Background

Growing use of medical imaging has led to an emerging concern over the amount of radiation exposure patients may accumulate during their lifetime. Specifically, the effect of orbit radiation exposure may lead to increased cataract development. Patients at risk of having an intraocular metallic foreign body (IOMFB) often have screening orbital plain radiographs performed prior to undergoing any magnetic resonance imaging (MRI). There are no published guidelines or studies that evaluate the minimum technique required to detect these metallic fragments with orbital plain films. As a result, radiation dose settings continue to vary with each individual institution.

## Study Aim

The purpose of this study was to assess the lowest mAs setting possible, while keeping kVp constant, to obtain orbital screening radiographs without decreasing the accuracy of IOMFB detection.

## Methods

- Four different size iron filings (0.12, 0.53, 1.10 and 1.95 mm) were placed on a prosthetic orbit model individually.
- Routine modified Waters' view technique was performed for screening orbital radiographs of the four sizes and a control group, holding kVp constant at 70 and decreasing mAs at five levels, beginning at standard mAs of 24.6 and decreasing stepwise by approximately 10 ms.
- Five plain films were obtained for each size and mAs combination with varying IOMFB position (randomized to left or right) for a total of 125 images.
- All images were obtained on a Philips Optimus 80 digital radiography unit.
- Orbital plain films were obtained in a randomized fashion & stored on the department PACS (Agfa, IMPAX version 6.3).
- Films were subsequently interpreted by six blinded radiologists of varying levels of experience (1-35 years, average 14.3) to detect the presence or absence of IOMFBs.
- The data were analyzed using SAS statistical software v9.2. Sensitivity, specificity and accuracy were calculated for each fragment size and mAs combination. Logistic regression was performed to assess the effect of fragment size on IOMFB detection.

## Orbital radiographs in modified Waters' view at standard settings (mAs 24.6, kVp 70)



Control - No iron filing



1.95 mm iron filing in right eye



0.53 mm iron filing in left eye

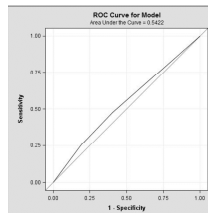
## Sensitivity, specificity and accuracy for radiation dose at varying iron filing sizes

mAs (calc/-)	Time (ms)	0.12 mm		0.53 mm		1.10 mm		1.95 mm		Total		
		Se	Acc	Se	Acc	Se	Acc	Se	Acc	Se	Sp	Acc
7.8	20	0.03	52%	0.13	56%	1.00	100%	0.93	97%	0.52	1.00	76%
12.5	32	0.00	48%	0.10	53%	1.00	98%	1.00	98%	0.53	0.97	74%
15.6	40	0.00	47%	0.10	52%	1.00	97%	1.00	97%	0.53	0.93	73%
19.5	50	0.27	62%	0.20	58%	1.00	98%	1.00	98%	0.62	0.97	79%
24.6	63	0.13	57%	0.20	60%	0.97	98%	1.00	100%	0.58	1.00	79%
Total		0.09	53%	0.15	56%	0.99	98%	0.99	98%			

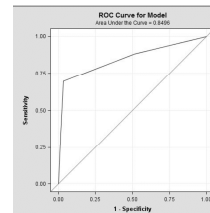
- For all fragment sizes, there appears to be very little improvement in sensitivity and accuracy by increasing radiation dose.
- Even with the standard (highest) dose of radiation, the 0.12 mm and 0.53 mm fragments only had sensitivities of 0.13 and 0.20, respectively.
- With larger size fragments, the radiation dose can be lowered while maintaining detection ability.

## Receiver Operating Characteristic Curves

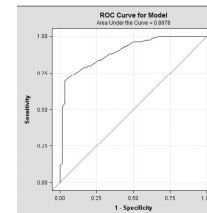
- Analysis of radiation dose only demonstrates poor ability to discriminate positive and negative results (area under the curve=0.54).
- Analysis of filing size only demonstrates good ability to classify results accurately, and improves slightly with inclusion of radiation dose (area under the curve=0.85 and 0.90 respectively).



Radiation Dose Only



Filing Size Only



Radiation Dose and Filing Size

## Results

- Sensitivity was high at all mAs settings for larger fragment sizes (1.10 and 1.95 mm sensitivity = 0.99).
- Sensitivity was low at all mAs settings for smaller fragment sizes (0.12 mm sensitivity = 0.09, 0.53 mm sensitivity = 0.15).
- According to regression results, fragment size explains 97% of the variance in detection of IOMFB ( $R^2=0.9716$ ).
- After controlling for fragment size and rater, decreasing the mAs has a small but statistically significant effect on detection ( $CI=1.009-1.060$ ) with the highest detection at 19.5 mAs and slightly lower detection at decreased mAs settings.
- There was no statistically significant difference in detection between settings of 19.5 and 24.6 mAs.

## Conclusion

- Decreasing mAs has little effect on sensitivity or accuracy of IOMFB detection for all tested fragment sizes.
- Standard mAs settings can be decreased to 19.5 mAs without a statistically significant difference in detection.
- Fragment size explains the majority of variation in detecting IOMFBs. Surprisingly, even at standard mAs settings, intraocular metallic fragments are mostly missed that measure 0.53 mm or less.
- These findings support the use of lower mAs settings in routine metallic foreign body screening of the orbits. However, it also raises awareness that many smaller metallic fragments may be routinely missed on screening orbital radiographs.

## Literature Cited

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