Quantitative Assessment of MRI Bore Fan Airflow and Its Association with Patient Warming Events

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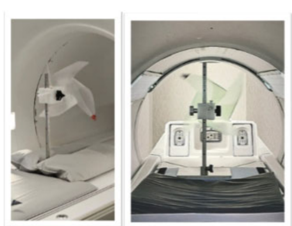
PURPOSE

- Radiofrequency (RF) power deposition during MRI can cause patient warming, leading to discomfort and potential motion artifacts [1-3].
- Convective heat removal within the magnet bore is provided by the built-in ventilation fan; however, fan performance is usually not quantitatively assessed during scanner acceptance or routine quality assurance (QA).
- This study aimed to develop a practical method to quantify MRI bore airflow and to evaluate its association with patient warming events.

METHODS

- Forty clinical MRI scanners were evaluated using a custom-built, non-metallic pinwheel anemometer. **(FIG. 1)**
- Measurement consistency was assessed on 14 scanners using both 30-second and 1-minute intervals.
- Following validation, standardized 30-second measurements were then performed on all scanners and converted to rotations per minute (RPM) at multiple locations (isocenter, anterior, left, and right) for two patient table configurations corresponding to typical head and body imaging positions.
- Patient warming events were documented by MRI technologists over a two-week period and included subjective complaints of excessive warmth and observable signs such as sweating.

FIG. 1: Custom-built anemometer and representative test positions in the MRI scanner bore.



RESULTS

- MRI bore fan airflow was reliably quantified using a simple, MR-safe pinwheel anemometer. Airflow measurements were highly reproducible, with no significant difference between 30-second and 1-minute sampling intervals (p=0.64). **(FIG. 2)**
- Airflow measurements expressed as rotations per minute (RPM) demonstrated good temporal stability. Across 40 MRI scanners, bore airflow exhibited substantial inter-scanner variability, with no consistent dependence on bore size, ranging from 0 to over 200 RPM. **(FIG. 3)**

FIG. 2: RPM measured in 30 seconds and 1 minute showed consistent results.

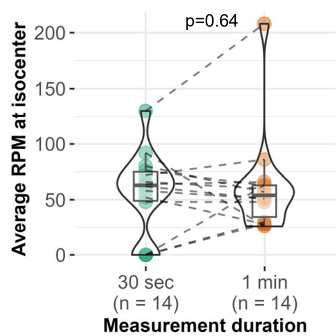
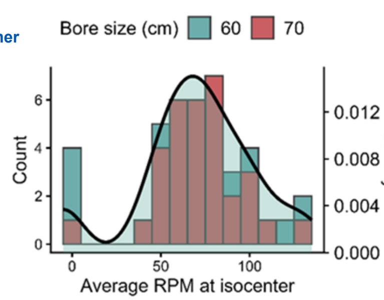


FIG. 3: Distribution of average bore fan RPM measured at the isocenter across 40 MRI scanners.



RESULTS (CONT.)

- In one scanner with near-zero airflow, placement of a table pad above the head end of the table successfully redirected airflow and increased measured RPM. **(FIG. 4A)**
- In another scanner, bore airflow increased substantially following fan replacement in both head and body imaging configurations. **(FIG. 4B)**
- Reduced bore airflow was strongly associated with patient warming events. Patient warming was reported on 18 scanners; among these, 12 (67%) demonstrated low airflow (0–66 RPM), including four scanners with nearly no detectable airflow. **(FIG. 5)**

FIG. 4: Examples showing the sensitivity of the measurement. (A) A scanner with near-zero RPM SUM initially. Placing a large pad above the head end of the table to redirect airflow resulted in increased RPM. (B) Another scanner had relatively low RPM readings and consequently underwent fan replacement to improve the airflow. Each data point represents a single RPM SUM measurement, calculated as the sum of RPM measured at the isocenter, anterior, left, and right locations.

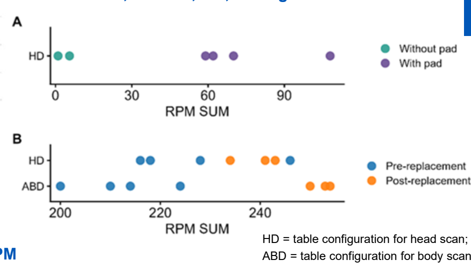
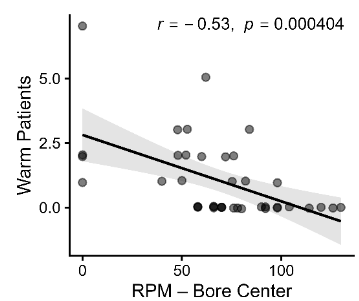


FIG. 5: Warming incidents associated with low airflow in the scanner bore.



DISCUSSION

- Collectively, these findings identify bore fan performance as a reliable, quantifiable parameter that varies widely across clinical systems and is closely related to patient comfort, supporting its inclusion in routine MRI quality assurance.
- Representative examples demonstrated the sensitivity of the measurement method to scanner conditions and workflow modifications.

CONCLUSIONS

- This study demonstrates that MRI bore airflow can be reproducibly quantified using a simple, MR-safe approach.
- The high variability observed across scanners and the strong association between low airflow and patient warming underscore the importance of incorporating bore airflow assessment into routine MRI QA to improve patient thermal comfort.

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