Broken Drill Bits During Surgical Procedures: A Review of 156 Patient Safety Events

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Abstract

Background: Broken surgical drill bits pose a risk to patient safety. A routine review of event reports submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS) uncovered an increase in the number of event reports related to broken drill bits, prompting an exploration to better understand patterns of drill bit breakage in Pennsylvania.

Methods: We queried the PA-PSRS database to identify event reports describing a broken drill bit during surgery submitted between January 1, 2021, and December 31, 2023. Event reports were manually coded to identify the procedure, anatomic location of breakage in the patient's body, timing of discovery, and fragment fate.

Results: A total of 156 relevant event reports were identified. The procedure being performed was determined in 64 of 156 event reports. Fracture repair procedures were most commonly reported to encounter a broken drill bit (27 of 64; 42.2%). We were able to determine the anatomic location in the patient's body where the drill bit breakage occurred in 108 of 156 event reports. The most commonly reported anatomic location was the femur (27 of 108; 25.0%). We were able to determine the fate of the broken drill bit in 141 of 156 event reports, and most drill bits were retained in the patient (99 of 141; 70.2%).

Conclusion: This data analysis provides insight into broken drill bits in Pennsylvania facilities. Because drill bits are commonly broken pieces of equipment and the fragments from these broken pieces are frequently retained, it is important to prevent drill bit breakage to improve patient safety. **Table 2** outlines prevention strategies established by equipment manufacturers and previous research. Implementing these strategies can address breakage across multiple procedures and patients.

Introduction

Instruments used in surgical procedures have the potential to break while in use, which can threaten patient safety. The rate of instrument breakage during emergency and elective orthopedic procedures is estimated to be between 0.18% and 0.35%.[1,2] Drill bits are one of the most frequently broken surgical instruments.[3-6] Retained drill bit fragments can threaten patient safety due to the potential for migration.[3,7,8] This is especially dangerous when fragments are retained near the spine,[7] pelvis,[8,9] or close to neurovascular regions.[6] Despite previous research outlining the prevalence of of and risks associated with broken drill bits, much of this research is derived from data from a single health system[1,2,9] or case studies[3,5,7,10] describing a single surgical case.

During a routine review of reports submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS)[a], we observed an increase in the number of events involving broken and retained drill bits during surgery. This led to an exploration of similar reports to summarize information related to broken surgical drill bits in Pennsylvania facilities. Our analysis will expand upon existing literature by including data from multiple facilities over a three-year period and providing prevention strategies from previous research and equipment manufacturers in a concise presentation.

Methods

Data Query

Data for this study were collected from event reports in the PA-PSRS database. PA-PSRS reports contain responses to structured fields (e.g., event date, patient age), as well as free-text narrative fields that allow reporters to describe event details in their own words. We queried the PA-PSRS acute care database for event reports submitted between January 1, 2021, and December 31, 2023, that contained the word "drill" within 10 characters of either "tip" or "bit" in the free-text fields (event details, event comments, event recommendations, event subtype - other). The query produced a total of 259 event reports that were manually reviewed for inclusion. Event reports met inclusion criteria if they described a drill bit breaking during a surgical procedure.

Variables Coded

We analyzed two sets of variables from the data available in the event reports. The first included patient age and sex, which were entered by the event reporter at the time of submission to PA-PSRS. The second set of variables was manually coded by the researcher and included the following:

- Procedure: Type of surgery that was being performed when the drill bit broke.
- Anatomic Location: Part of the patient's body in which the drill bit broke or where the drill bit fragment was found.
- Timing of Discovery: When the broken drill bit, or drill bit fragment, was found in relation to the procedure.
    - During Procedure: Any time during the procedure before closing (i.e., the time the surgical wound is stitched, stapled, or otherwise adhered as an end to the surgery).
    - Postoperatively: Any time after the closing of the surgical wound.
    - Unknown: The timing of discovery was unable to be determined from the information provided.
- Fragment Fate: The outcome involving the piece(s) of the broken drill bit after the original procedure (i.e., the procedure during which the broken drill bit occurred).

Data Analysis

We performed a descriptive data analysis to identify patient demographics and patterns in drill bit breakage.

Results

Demographics

Manual review of event reports identified a total of 156 relevant event reports from 72 facilities. Across all event reports, 59.6% (93 of 156) involved male patients, and 39.1% (61 of 156) involved female patients. The sex of two patients was not provided. The mean patient age was 52.2 years, ranging from 16 to 90 years. Over half (57.7%; 90 of 156) of the broken drill bit events occurred in patients over 50 years old.

Procedure and Anatomic Location

We were able to identify the type of procedure that resulted in a broken drill bit in 64 of the 156 event reports. **Figure 1** shows the procedures related to a broken drill bit. Most broken drill bits occurred during a fracture repair (42.2%; 27 of 64) or a joint replacement surgery (20.3%; 13 of 64). Details of the fracture repairs and joint replacements are outlined in **Table 1**.

We were able to determine the anatomic location in which the drill bit broke in 108 of the 156 event reports. Broken drill bits most frequently occurred in the femur (25.0%; 27 of 108). **Figure 2** shows the anatomic locations of the broken drill bits.

Timing of Discovery

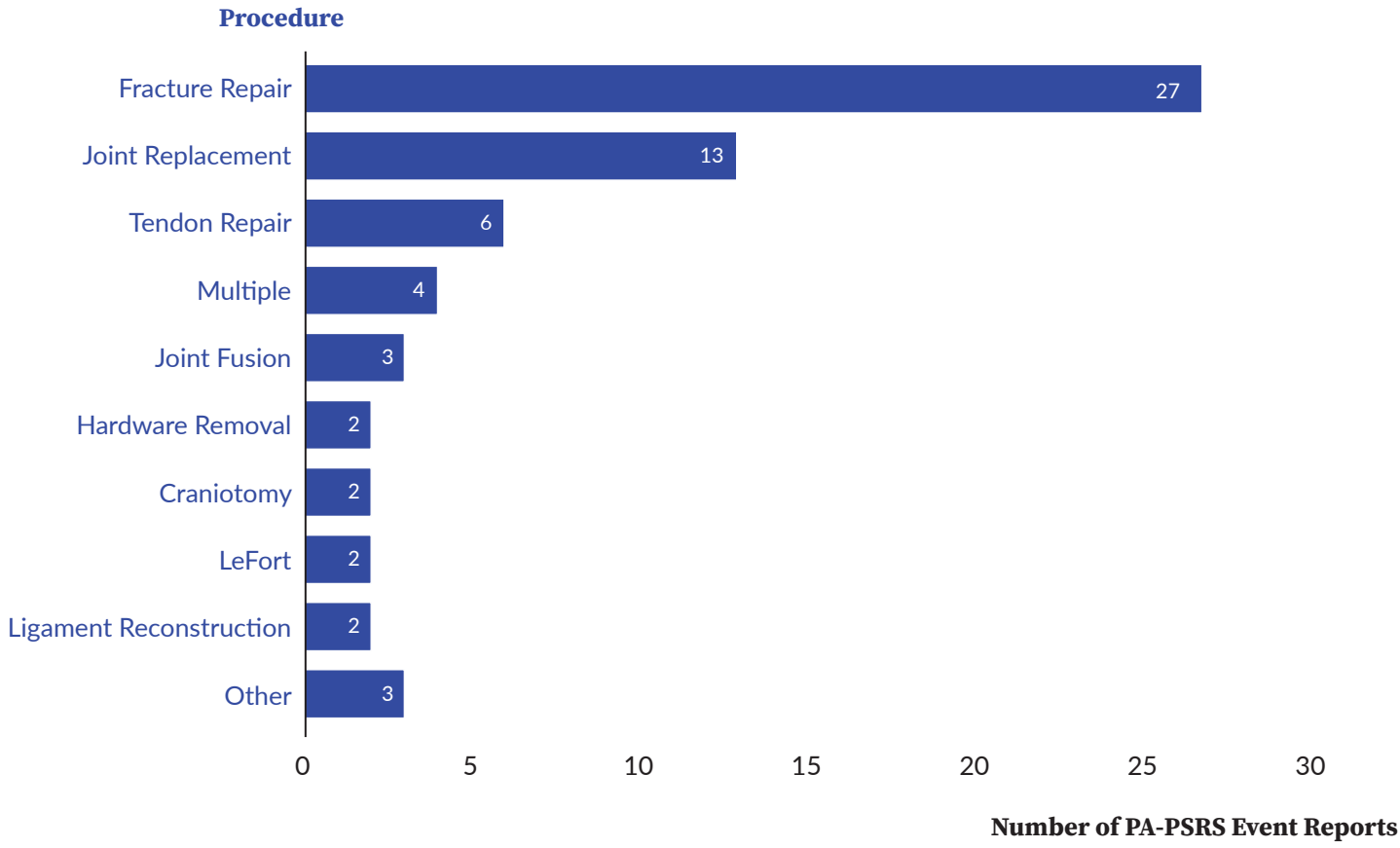
Figure 3 shows the frequency and percentage of the timing of when the broken drill bit was discovered. In 93.6% (146 of 156) of event reports, the broken drill bit was discovered during the procedure. The broken drill bit was discovered postoperatively in 2.6% (4 of 156) of event reports.

Fragment Fate

We were able to determine the fate of the drill bit fragment(s) in 141 of the 156 event reports. The fragments were removed during the original procedure in 29.8% (42 of 141) of event reports. Over two-thirds (70.2%; 99 of 141) of the event reports indicate that the fragments were retained following the original procedure. Of the 99 event reports with a retained fragment, 97 describe no further intervention and two describe fragment removal during a subsequent surgery.

[a]PA-PSRS is a secure, web-based system through which Pennsylvania hospitals, ambulatory surgical facilities, abortion facilities, and birthing centers submit reports of patient safety–related incidents and serious events in accordance with mandatory reporting laws outlined in the Medical Care Availability and Reduction of Error (MCARE) Act (Act 13 of 2002).[11] All reports submitted through PA-PSRS are confidential and no information about individual facilities or providers is made public.

Figure 1. Procedures Involving Broken Drill Bits, N=64* PA-PSRS Event Reports



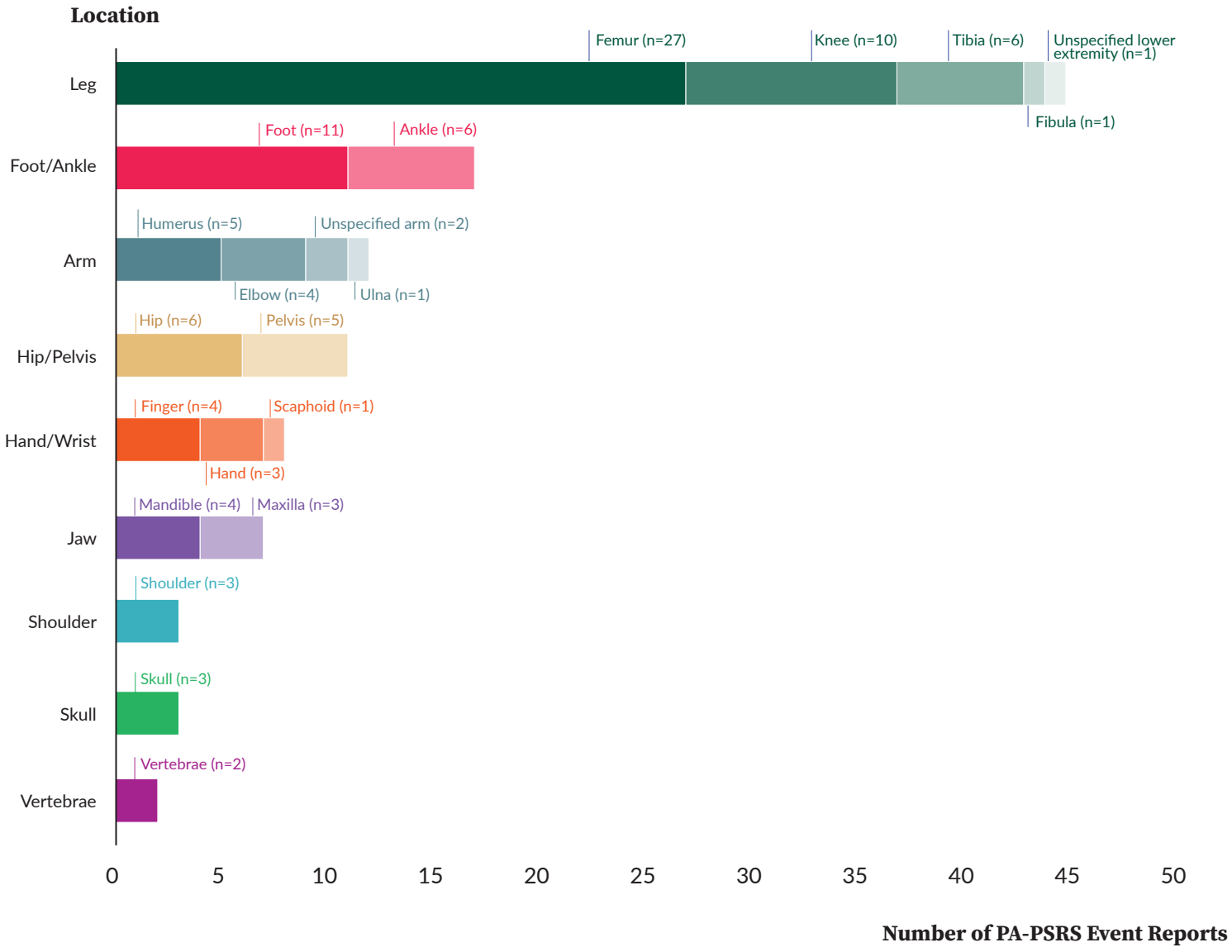
*Note: There were 92 event reports with no procedure specified. Each of the 64 event reports was coded as having only one procedure category.
"Multiple" was coded when the event report described multiple procedures in a localized part of the body (i.e., foot, ankle, hand) and we were not able to determine during which procedure the broken drill bit occurred.
LeFort is a surgery that repositions the upper jaw to correct midface deformities.
"Other" includes excision of heterotopic bone, curettage and cementation with internal fixation, and osteotomy with internal fixation/cementation.

Table 1. Details of Fracture Repair (n=27) and Joint Replacement (n=13) Procedures

Procedure	Procedure Details	Number of PA-PSRS Event Reports
Fracture Repair	Femur	9
	Tibia/Fibula	4
	Hand	3
	Hip	3
	Elbow	2
	Humerus	2
	Mandible	2
	Ankle	1
	Unspecified	1
Joint Replacement	Hip	8
	Shoulder	3
	Knee	2

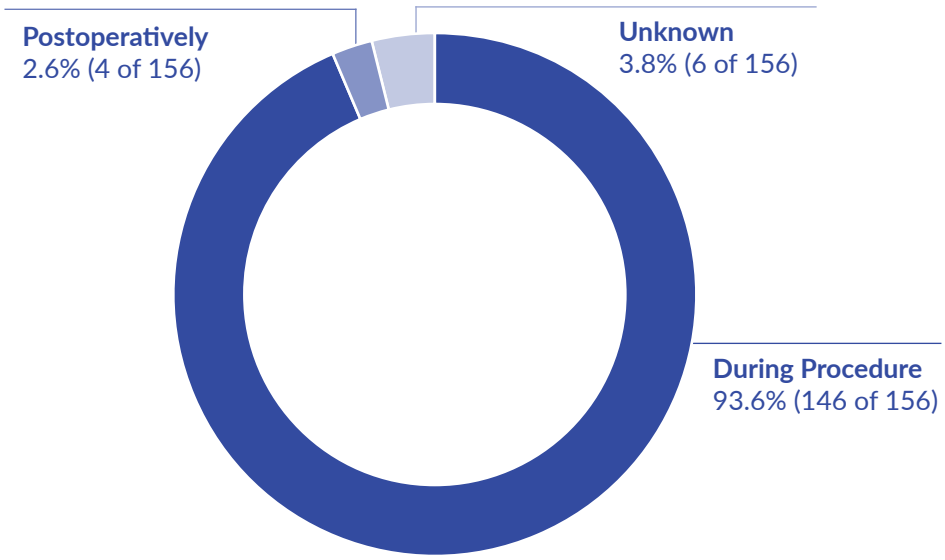
Note: Details in this table relate to the procedure identified in the event report and may not reflect the exact location in the patient's body where the broken drill bit occurred.

Figure 2. Anatomic Location in Which Drill Bit Breakage Occurred, N=108* PA-PSRS Event Reports



***Note:** There were 48 event reports with no location specified. Each of the 108 event reports was coded as having only one location.

Figure 3. Timing of Discovery of Broken Drill Bits, N=156 PA-PSRS Event Reports



Discussion

Our analysis outlines the procedures, locations, discovery information, and fragment fate related to 156 events involving broken drill bits submitted by Pennsylvania facilities over a three-year period. Retained fragments from broken drill bits have the potential to negatively impact patient safety by requiring additional surgeries for removal, increasing exposure to unnecessary radiation from X-rays,[12] and/or raising the risk of complications in the event of fragment migration.[3,7]

Although removing broken drill bit fragments is recommended,[1,10] the risks must be weighed against the benefits. Removal can increase the risk of damage to surrounding areas, which may lead to surgeons deciding to leave the fragment in place.[5,6] While the immediate risks of removal may outweigh the benefits, the risk to patient safety is a concern.[3]

Data from this analysis highlights procedures and anatomic locations that were reported to result in a broken drill bit. Our data shows that broken drill bits occur in both male and female patients and across a range of patient ages. While broken drill bits occurred most frequently during a fracture repair procedure, it is important to consider that fracture repairs are a common surgical procedure.[13] This suggests that the high frequency of broken drill bits during fracture repairs could be due to the volume of fracture repair procedures and not because fracture repairs are at particularly high risk for drill bit breakage.

Our analysis shows that drill bit breakage occurred across a range of procedures and in varied anatomic locations, highlighting the need to understand and implement strategies to prevent drill bit breakage across all procedures. Due to the unknown cause(s) of drill bit breakage in our dataset, we chose to focus on existing literature and clinical knowledge when giving recommendations to prevent drill bit breakage. Previous research[4,6,9,16] and information from medical device manufacturers[17-19] provide strategies for preventing drill bit breakage during use in surgery. These strategies, which can be categorized as surgical technique; sterilization, reprocessing, and storage; and general safety measures, are provided in **Table 2**.

Limitations

The quality of information provided in the free-text fields of PA-PSRS event reports varies, and some reports contain more detailed information than others. Our analysis is limited by the information provided. With many event reports missing information related to the type of procedure and anatomic location, we did not explore relationships between these and other variables, as they may misrepresent true relationships and associations due to the missing data. We were also unable to determine the specific reason(s) for drill bit breakage because most event reports do not contain this type of detail. Furthermore, the exact cause may be unknown to the event reporter. In addition, despite mandatory reporting laws in Pennsylvania, it is possible that the events reported to PA-PSRS may not represent all occurrences of broken drill bits during surgery.

Table 2. Strategies to Prevent Drill Bit Breakage During Use in Surgery

Prevention Category	Strategies
Surgical technique	Avoid applying excessive lateral force,[17] high twisting force,[17,19] and excessive drilling speeds[17] when drilling, especially in areas of the body that cause the drill bit to bend due to the patient's anatomy[4,6]
	Avoid contact with metallic implants[9,17]
Sterilization, reprocessing, and storage	Do not use corrosive cleaning/disinfecting agents, such as those containing chloride, bromine, bromide, iodine, iodide, or active chlorine[18]
	Do not use steel wool, wire brushes, pipe cleaners, or abrasive detergents[18]
	Neutral pH detergents are preferred for disinfecting[18]
	Ensure the solution used for soaking drill bits is approved by the manufacturer for each specific drill bit[18]
	Do not soak in any solution for more than two hours[18]
	Grip instruments securely when blow-drying with pressurized air to prevent damage from air pressure[18]
	After cleaning and before sterilization, moving parts should be lubricated with a physiologically safe lubricant[18]
	Do not place heavy objects on top of drill bits during storage[19]
General safety measures	Carefully inspect the drill and drill bit for breaks, cracks, or malformations before use (magnification is recommended)[18]
	Before use, ensure the drill bit runs concentrically (in a circle) and does not wobble or otherwise run incorrectly[19]
	Ensure that the drill bit is compatible with the drill being used[6]
	If a drill bit is labeled as single use, it should not be reused or reprocessed[17-19]
	Verify that drill bits are properly inserted and tightened before use[17]
	Read and understand the instructions for use of equipment being used, as equipment can be highly specialized and may not be appropriate for multiple applications[17-19]
	Avoid overuse of drill bits[9] and replace when signs of wear are visible, or the bit has reached its maximum number of uses according to the manufacturer[16]

Conclusion

Previous literature[1-6] has identified drill bits as surgical equipment that commonly breaks during use. This information, combined with data from this analysis describing fragments that were retained in high-risk anatomic locations or that required a return to surgery for fragment removal, shows that drill bit breakage can threaten patient safety in Pennsylvania. Implementing strategies to prevent drill bit breakage is key to reducing the potential negative impact on patient safety.

Notes

This analysis was exempted from review by the Advarra Institutional Review Board.

Data used in this study cannot be made public due to their confidential nature, as outlined in the Medical Care Availability and Reduction of Error (MCARE) Act (Pennsylvania Act 13 of 2002).

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