VOLUME 16 • DECEMBER 2023

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Original Research

Health Literacy Analytics of Accessible Patient Resources in Cardiovascular Medicine: What are Patients Wanting to Know?

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Received May 22, 2023; Accepted for publication Dec. 21, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.20554

ABSTRACT

Introduction. There remains an increasing utilization of internet-based resources as a first line of medical knowledge. Among patients with cardiovascular disease, these resources often are relied upon for numerous diagnostic and therapeutic modalities. However, the reliability of this information is not fully understood. The aim of this study was to provide a descriptive profile on the literacy quality, readability, and transparency of publicly available educational resources in cardiology.

Methods. The frequently asked questions and associated online educational articles on common cardiovascular diagnostic and therapeutic interventions were investigated using publicly available data from the Google RankBrain machine learning algorithm after applying inclusion and exclusion criteria. Independent raters evaluated questions for Rothwell's Classification and readability calculations.

Results. Collectively, 520 questions and articles were evaluated across 13 cardiac interventions, resulting in 3,120 readability scores. The sources of articles were most frequently from academic institutions followed by commercial sources. Most questions were classified as "Fact" at 76.0% (n = 395), and questions regarding "Technical Details" of each intervention were the most common subclassification at 56.3% (n = 293).

Conclusions. Our data show that patients most often are using online search query programs to seek information regarding specific knowledge of each cardiovascular intervention rather than form an evaluation of the intervention. Additionally, these online patient educational resources continue to not meet grade-level reading recommendations.

Kans J Med 2023;16:309-315

INTRODUCTION

Cardiovascular disease continues to remain a leading cause of morbidity and mortality among individuals throughout the world.[1] In the United States, healthcare expenditures on the management of this disease have increased by over 100 billion dollars in the past 20 years.[2] As a result, there is a continued investment of resources in innovative healthcare systems and processes that continue to transform cardiovascular patient care, including facets such as decision-making models, diagnostic and therapeutic interventions, and patient understanding of these innovations.[3] Regarding patient understanding, there remains an increasing utilization of internet-based resources as a first line of medical knowledge.[4] With the advancement of technology and the widespread availability of internet access, patients have the convenience to access an abundance of healthcare educational information at their fingertips, and the global utilization of these resources continues to expand. However, the navigation of this abundance can be an obstacle given the overwhelming amount of information unregulated for content accuracy, quality, readability, and transparency.[4-7] Therefore, it is vital to equip patients with the essential tools and education to actively participate in their informed decision-making process.

In cardiovascular medicine, patient education is pivotal in the management of diverse conditions such as hypertension, coronary artery disease, and heart failure. It also serves to inform patients about diagnostic and treatment modalities.[8,9] A critical component of patient education is health literacy. This concept is an individual's capacity to obtain healthcare information and interpret it in a manner that promotes the maintenance or enhancement of their health within a suitable context.[10] The literature consistently demonstrates that a decline in healthcare literacy or the presence of poor healthcare literacy is correlated with an elevated risk of adverse health outcomes, such as increased hospital admissions and higher healthcare costs.[11-14]

With the wealth of Internet-based educational resources available, a patient's online healthcare literacy is crucial in the realm of cardiovascular medicine. However, there remains a paucity of data evaluating the quality and content of the informational resources provided to patients in an online setting. The current literature on online cardiovascular disease education relatively has focused on disease education rather than diagnostic and therapeutic cardiac interventions which patients may be involved with during their disease management.[15-18] This scarcity of information can hinder our comprehension of the existing landscape of online healthcare resources and diminish the focus on enhancing these resources if they fail to adequately educate patients on the subject matter. Therefore, the aim of this study is to describe and characterize the healthcare literacy profile of online patient educational materials on diagnostic and therapeutic cardiac interventions.

METHODS

To address the primary aim of this study, we performed a cross-sectional study in April 2023 to characterize components of healthcare literacy.[19] This study did not require institutional review board approval given that it did not require human participants or animal subjects, and all the data utilized in this study were publicly available. The authors utilized a machine learning-based search engine algorithm, specifically RankBrain (Google, Mountain View, CA).[20-23] In this public machine learning application, the most frequently asked questions were queried until the first unique 20 were extracted from the following categories: cardiac catheterization, percutaneous coronary intervention, balloon angioplasty, atherectomy, intra-aortic balloon pump, transcatheter aortic valve replacement, laser angioplasty, ventricular assist device, coronary artery calcium scan, echocardiogram, electrophysiology study, electrocardiogram, cardiac pacemaker. The choice of these categories was based on findings reported in previous literature.[24-28] The first 40

questions and associated articles of each category were extracted based on these inclusion criteria: (1) the question and article are written in the English language, (2) the articles were publicly accessible without the creation of a subscription account or payment, (3) each article was at least 100 words, and (4) articles were extracted from the same search query.

After extracting each question and corresponding article, four independent reviewers evaluated each question per Rothwell's Classification of Questions as demonstrated in previous literature.[20,29-33] This classification was modeled after previous literature, as Rothwell's Classification of Questions broadly categorizes the questions into the following categories: "Fact", "Policy", or "Value".[20,21,29-33] Additionally, these three categories were further subclassified by the raters into each respective group. This included questions regarding specific activities, length of time, restrictions, technical details, or costs within the "Fact" category. Questions within the "Policy" category were further subclassified as questions regarding either indications or complications. Questions within the "Value" category were further subclassified as questions regarding the evaluation of credibility or risk/benefit appraisal.[21,29-31,33]

The corresponding educational articles, also addressed as an "educational resource" in this study, were further evaluated for content readability as shown in previous literature.[33] Specifically, the literature content of the educational article was reformatted to plain text, Times New Roman, 12-point font, on Microsoft® Word to allow raters to efficiently calculate readability scores for each resource. Additionally, resources were reformatted to remove author information, copyright disclaimers, figures, captions, legends, references, and web page navigation hyperlinks prior to the calculation of scores and standard deviation (SD) as outlined in previous literature. No content was revised or reviewed for source appraisal. Raters were then instructed to perform the following readability calculations after resource reformatting: Flesch Kincaid Grade Reading Level, Flesch Reading Ease, Gunning-Fog Index Readability, Coleman-Liau Index, Simple Measure of Gobbledygook (SMOG)Index, and Linsear Write Formula. The selection of these formulas was modeled on previous literature (Table 1).[33,34] The use of readability calculations in this methodology was to serve as a modality to determine the quality and comprehension of these patient education resources as described in the aim of this study. Moreover, the use of these calculations can determine if the patient educational resources regarding each cardiac intervention meets reading level recommendations in the U.S. Educational resources which do not meet this recommendation can be considered more complex in terms of comprehension for patients. Regarding data tabulation, raters recorded all data using Microsoft® Excel 2021 (Microsoft Corporation, Redmond, WA), and the date of the search queries also was tabulated to minimize potential ambiguity in data extraction.[34-36] Inter-rater reliability was used to determine the degree of similarity among raters when quantifying Rothwell's Classification of Questions. The use of this calculation would determine the degree of validity among the results.

RESULTS

There was a collective of 520 questions and associated articles across 13 cardiovascular interventions that were successfully extracted based on inclusion and exclusion criteria. Most articles (95.6%, n = 497) were from the U.S., followed by the United Kingdom (3.1%, n = 16). Nearly 31% (n = 161) of the articles were from academic institutions, 30.4% (n = 158) from commercial sources, 15.8% (n = 82) from government sources, 15.4% (n = 80) from medical practice, and 7.5% (n = 39) from media outlets. Table 2 contains further course classification by the cardiovascular intervention of interest. Precisely, no source classification succeeded in over 40% of each category among the 13 cardiac interventions.

Regarding the 520 frequently asked questions extracted by the raters, there was an inter-rater reliability at 96.9% among Rothwell's Classification of Questions. Most of the questions were classified as "Fact" at 76.0% (n = 395), followed by "Value" at 14.2% (n = 74), and "Policy" at 9.8% (n = 51; Table 3). Further subclassification of questions within each category demonstrated that questions regarding "Technical Details"- a subclassification of the "Fact" category - of each cardiac intervention were most common at 56.3% (n = 293), followed by the subclassification regarding "Evaluation of the Surgery" - a subclassification of the "Value" category - at 8.5% (n = 44).

Regarding readability, a total of 3,120 readability scores were calculated from the 520 articles extracted in this study using six readability formulas (Table 4). Educational resources with content regarding an electrophysiology study had the lowest Flesh-Kincaid score at 10.2 (SD = 2.4), whereas resources regarding transcatheter aortic valve replacement had the highest Flesh-Kincaid score at 12.8 (SD = 6.8). Among Flesh Reading Ease calculations, resources regarding echocardiogram had the highest readability score at 67.4 (SD = 85.3), whereas resources regarding percutaneous coronary intervention had the lowest readability score at 43.4 (SD = 16.7; Figure 1). Among Gunning-Fog calculations, the average score was highest among resources regarding intra-aortic balloon pumps at 15.1 (SD = 5.9), and the lowest average score was among resources regarding echocardiograms at 12.6 (SD = 2.0). Among Coleman-Liau Index, the average score was highest among resources regarding percutaneous coronary intervention at 11.8 (SD = 2.6), and the lowest average score was the same between resources regarding laser angioplasty at 10.7 (SD = 1.7) and regarding echocardiograms at 10.7 (SD = 1.7).

Among SMOG calculations, the average score was highest among resources regarding percutaneous coronary intervention at 10.9 (SD = 2.1) and the lowest average score was among resources regarding echocardiograms at 9.2 (SD = 1.3). Among Linsear-Write calculations, the average score was highest among resources regarding transcatheter aortic valve replacement at 13.2 (SD = 5.1) and ventricular left assist devices at 13.2 (SD = 4.4), and lowest average score was among resources regarding an electrophysiology study at 10.8 (SD = 3.0).

Table 1. Readability calculations.

Readability Calculation	Formula
Flesch Kincaid	0.39 x (words/sentences) + 11.8 x (syllables/words) – 15.59
Flesh Reading Ease	206.835 - 1.015 × (total words ÷ total sentences) - 84.6 × (total syllables ÷ total words)
Gunning Fog	0.40 [(words/sentences) + 100 (complex words/words)]
Coleman-Liau	0.0588 (average number of letters per 100 words) – 0.296 (average number of sentences per 100 words) – 15.8
Simple Measure of Gobbledygook (SMOG)	3 + √(number polysyllabic words)
Linsear Write	4.71(characters/words) = 0.5(words/sentences) – 21.43

Table 2. Source frequency of educational materials on cardiac interventions.

Cardiac Intervention	Academic Institution	Commercial	Government Website	Media Outlet	Medical Practice
Atherectomy	10	10	11	2	7
Balloon Angioplasty	10	9	8	9	4
Cardiac Catheterization	15	11	8	2	4
Cardiac Pacemakers	8	9	10	6	7
Coronary Artery Calcium Scan	13	14	3	1	9
Echocardiogram	13	13	4	1	9
Electrocardiogram	12	16	3	1	8
Electrophysiology Study	15	12	4	0	9
Intra-aortic Balloon Pump	11	10	6	7	6
Laser Angioplasty	12	12	6	4	6
Percutaneous Coronary Intervention	10	10	7	5	8
Transcatheter Aortic Valve Replacement	16	16	8	0	0
Ventricular Assist Device	16	16	4	1	3

Table 3. Frequency table of Rothwell's Classification of Questions on cardiac interventions.

Cardiac Intervention	Fact	Policy	Value
Atherectomy	26	10	4
Balloon Angioplasty	32	4	4
Cardiac Catheterization	28	3	9
Cardiac Pacemakers	34	3	3
Coronary Artery Calcium Scan	36	1	3
Echocardiogram	34	4	2
Electrocardiogram	30	4	6
Electrophysiology Study	35	5	0
Intra-aortic Balloon Pump	27	2	11
Laser Angioplasty	33	1	6
Percutaneous Coronary Intervention	30	1	9
Transcatheter Aortic Valve Replacement	23	6	11
Ventricular Assist Device	27	7	6

Table 4. Readability calculations of educational materials on cardiac interventions.

Cardiac Interventions	Flesch Kincaid Average *SD*	Flesch Reading Ease Average *SD*	Gunning-Fog Average *SD*	Coleman-Liau Index Average *SD*	SMOG Average *SD*	Linsear Write Average *SD*
Atherectomy	11.4	45.0	14.3	11.5	10.6	12.2
	3.2	*17.6*	*3.2*	*2.5*	*2.4*	*3.9*
Balloon Angioplasty	11.2	47.8	14.0	11.0	10.3	12.3
	2.5	*13.3*	*2.5*	*1.6*	*1.7*	*3.4*
Cardiac Catheterization	10.9	49.9	14.0	10.8	10.3	12.3
	2.7	*16.0*	*3.0*	*2.3*	*2.1*	*3.2*
Cardiac Pacemakers	10.4	51.8	13.4	10.9	9.9	11.4
	2.2	*12.5*	*2.4*	*2.2*	*1.7*	*2.9*
Coronary Artery Calcium Scan	11.3	47.0	14.2	10.9	10.6	12.5
	2.1	*12.3*	*2.5*	*2.2*	*1.7*	*2.9*
Echocardiogram	12.1	67.4	12.6	10.7	9.2	10.9
	2.9	*85.3*	*2.0*	*1.7*	*1.3*	*2.8*
Electrocardiogram	10.3	53.0	13.3	10.9	9.7	11.6
	3.1	*17.1*	*3.3*	*2.5*	*2.4*	*3.8*
Electrophysiology Study	10.2	51.8	13.5	10.9	9.8	10.8
	2.4	*13.8*	*3.5*	*2.0*	*1.9*	*3.0*
Intra-aortic Balloon Pump	11.5	44.0	15.1	11.3	10.7	12.4
	3.5	*19.9*	*5.9*	*2.7*	*2.6*	*4.1*
Laser Angioplasty	11.2	48.5	14.4	10.7	10.5	12.6
	3.0	*13.2*	*3.2*	*1.7*	*2.3*	*5.0*
Percutaneous Coronary Intervention	11.9	43.4	14.7	11.8	10.9	12.9
	2.8	*16.7*	*2.9*	*2.6*	*2.1*	*3.3*
Transcatheter Aortic Valve Replacement	12.8	44.3	14.6	11.1	10.7	13.2
	6.8	*16.5*	*3.5*	*2.3*	*2.4*	*5.1*
Ventricular Assist Device	11.5	50.5	14.0	10.9	10.4	13.2
	4.1	*14.4*	*3.2*	*1.6*	*2.4*	*4.4*

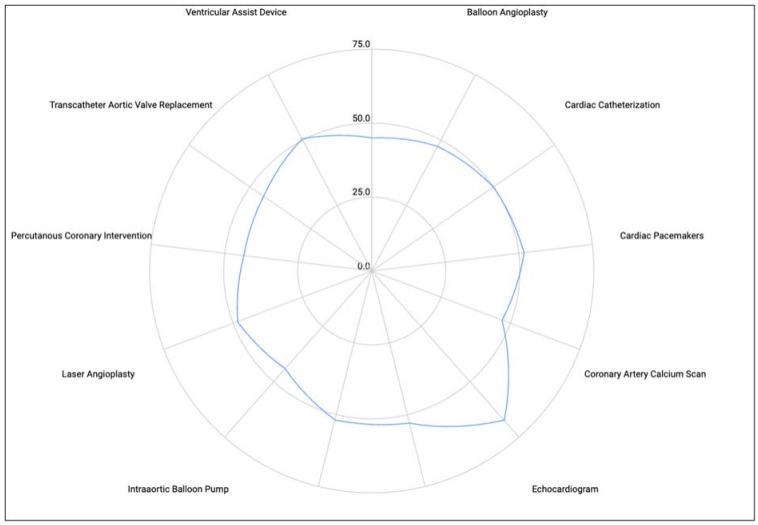

Figure 1. Illustration of Flesch Reading Ease among cardiac interventions.

DISCUSSION

The rapid evolution of internet accessibility by the public, as well as the degree of oversight on fact-verification or resource credibility, creates a continuous need to evaluate and describe the climate of online health literacy.[34-37] Similarly, information-seeking behavior among patients using these online resources, contributed by resource convenience, can play a role in the physical and mental health of a patient. Moreover, there is literature that suggests improper information-seeking behavior may be related to high-risk behaviors, including improper medication use, as well as reduced optimization in cardiovascular care.[38-40] To address this current climate, this research investigation provided a descriptive profile of publicly available online educational resources and questions regarding clinical cardiovascular interventions.

Among all patient education resources included in this study, the source origin of most articles was from the U.S. at 95.6%, followed by the United Kingdom at 3.1%. These findings enable us to establish a geographical localization within our dataset.[41] They suggest that the dataset of patient education materials used in this study would be most relevant for users seeking medical care within the U.S. healthcare infrastructure. Therefore, these findings may not be as informative for patients seeking information on these cardiac interventions in other countries, where guidelines, recommendations, and provisions may differ from those in the U.S.[42,43] For example, the difference in insurance reimbursement structure schemes may vary among patients who enquire about a specific cardiac intervention (i.e., echocardiography) in the U.S. and in a different country.[1,2,41,42] This can potentially account for a difference in the amount of applicable information, which can be relevant to the patient. Additionally, the most frequent source classification of articles was heavily composed of academic institutions at 31% and commercial sources at 30.4%. The prevalence of academic institutions in this dataset also implies a higher likelihood that the authors of each online education resource are affiliated with an academic setting rather than a privately employed practice. Additionally, educational materials from academic sources may have more interest to utilize literature using clinical research data compared to commercial sources which could rely on the potential utilization of aspects, such as physician credibility or medical brands.[43-45]

The results of Rothwell's Classification of Questions in this study may indicate that patients are leaning toward seeking information regarding cardiac interventions rather than asking questions that evaluate the policies or perspectives of cardiac interventions. This finding could indicate that there is a curiosity present among patients and that may be due to a generalized paucity of knowledge regarding these cardiac interventions, or potentially due to a lack of content that appropriately answers the questions asked by patients in the U.S. Moreover, a majority of questions were focused on the technical details regarding each procedure compared to other subclassifications in the "Fact" category. This discovery is intriguing, particularly when contemplating the vital role that questions about costs or restrictions play in a patient's education about cardiac interventions. It implies a scarcity of inquiries related to costs, indicating that patients may be directing such queries to alternative sources, such as their health insurance provider or physicians, rather than seeking information online.[20,46-48] Future research should focus on comparing quality of primarily cost-based patient education resources on cardiac interventions.

The results of this readability analysis suggest that there is a generalized paucity of online patient education materials which meet institutional recommendations that the reading level of a resource should not be greater than the sixth-to-eighth-grade reading level.[49-51] However, there are certain cardiac interventions that have readability scores that may require greater attention toward improvement.[52,53] Specifically, patient education materials regarding percutaneous coronary interventions had the lowest Flesh-Reading Ease score at 43.4, which would indicate "difficult to read". Similarly, percutaneous coronary interventions had the highest Coleman-Liau index and SMOG calculations among all cardiac interventions. This finding creates further validity to the greater need to improve the readability of materials on this intervention.[53-55] Similarly, the readability scores on coronary artery calcium channel screening suggest that there remains a need to improve these materials, as readability scores have not improved since a similar analysis performed by Rodriguez et al.[56] in 2020.

To the best of our knowledge, this is the first published study that utilizes Rothwell's Classification of Questions and readability of online patient education materials on cardiac interventions in the U.S. A key strength of this study is the plan to analyze the Google RankBrain algorithm as the search query system comprises over 90% of the market share of the internet search query. Future studies ought to implement additional query programs to further increase the generalizability of these findings. Additionally, this methodology analyzed a sample size of online patient educational materials in cardiovascular medicine compared to previous literature.

Limitations. The study has limitations. Specifically, while this study employs health literacy assessment tools that are well-established in the literature, these tools do not assess the accuracy of content information among each educational resource material.[20,21,57-60] Future studies ought to develop a measurement tool to assess for information transparency

and accuracy in online educational articles. Similarly, the subjective nature of these assessment tools does not consider the potential overlap between categories when assessing questions. Although this study had a high interrater reliability of over 95%, there remains the potential to create the need for similar studies to validate these findings.

CONCLUSIONS

Overall, the findings of this study provide clinicians a direction toward improving the health literacy of patients in cardiovascular medicine. This study utilizes a machine learning algorithm to describe and assess questions commonly posed by the public audience. The findings of this study demonstrate that patients more often seek information regarding specific knowledge of each cardiovascular intervention rather than use it for value or policy-based questions or to seek advice. However, the current body of publicly available online educational literature does not meet grade-level reading recommendations across all interventions analyzed in this study. These findings encourage the need for improving literacy comprehension regarding these contemporary educational materials. Future studies ought to investigate efficacious solutions for creating general readability which can adapt to the continuously growing use of the internet.

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Keywords: health literacy, patient education, cardiology, cardiac intervention, readability

KANSAS JOURNAL of MEDICINE

Brief Report

Use of Electrocautery to Facilitate Suture Passage Through the Greater Trochanter of the Femur: A Biomechanical Study

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Received July 20, 2023; Accepted for publication Dec. 21, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.21132

ABSTRACT

Introduction. The specific aims of this study were to evaluate (1) the axial force reduction of suture passage utilizing electrocautery when applied to the greater trochanter of the femur, (2) the temperature change caused while using electrocautery for suture passage, and (3) the failure loads and failure modes utilizing this technique.

Methods. Five matched pairs of fresh-frozen femurs were used and classified into two groups: with electrocautery on needle (study group) and without electrocautery on needle (control group). Two bicortical, osseous tunnels were made around the insertion of the gluteus medius tendon. Each specimen was sequentially tested in a needle penetration test and a single load-to-failure test. A #5 Ethibond suture with a straight needle was used.

Results. Electrocautery reduced the peak axial force for bone penetration in 40% (near cortex) and 70% (far cortex) of the trials, and no significant difference was detected between groups or between two osseous tunnels. The average peak force was significantly higher for the far cortex for both groups and for both osseous tunnels compared to the near cortex. There was no significant change in temperature of the tunnel site with electrocautery. Ninety percent of the samples experienced bone tunnel failure for the study group compared to 70% in the control group. The average ultimate failure load for the study group was lower compared with the control group, but this finding was not statistically significant (range: 6%-15%).

Conclusions. Suture passage using electrocautery may not significantly decrease the peak force needed to pass a needle directly through the greater trochanter. ***Kans J Med 2023;16:316-320***

INTRODUCTION

Surgical repair of the hip abductor tendon is a common orthopaedic procedure that is usually performed during primary repair of an acute or chronic tear in isolation or, more commonly, during total hip arthroplasty.[1,2] There are numerous approaches described to gain access to the hip in primary and revision hip arthroplasty, including anterolateral and direct lateral approaches that intentionally release abductor insertions about the hip and necessitate repair at the conclusion of the procedure.[3] Though less common, inadvertent injury to the hip abductor tendons may occur during an anterior or posterior approach which would also require repair. Abductor repair involves direct re-attachment of the tendon to the greater trochanter of the femur through a bone tunnel using a heavy needle, drill, burr, awl, or tunnel device.[4-8] These techniques require additional equipment and implants, which not only add operative set up time and cost to a surgical case, but also contribute to increased difficulty during revision cases from implants littering the surgical field. Because of rising healthcare costs, surgeons must consider the costs associated with an implant relative to potentially equivalent, less costly, and/or implant-free methods.

One technique for repairing a hip abductor tendon to the bone is by simply passing suture needles directly through bone using the mechanical advantage from a needle driver.[4,6] Bone tunnels created by needle are more efficient, more cost effective, and provide an equivalent outcome in comparison to techniques that require implants or specialized tools.[4,5] However, passing suture needles directly through the greater trochanter often is difficult or impossible depending on the bone quality and cortical thickness.[9,10] This can be dangerous for both the patient and the surgeon. Techniques that decrease the peak axial force required to pass the needle gives the surgeon greater control over the needle/needle driver and decrease iatrogenic injury risk. The literature has described the use of electrocautery as a technique to expedite the passage of a suture needle through bone, eliminating the need for a drill or burr. This method aims to save time, conserve operative resources, and reduce associated risks. Previous biomechanical studies using this technique have identified a 36% - 48% average reduction in peak axial force to pass a suture needle through bone.[6,11] This technique, in theory, has multiple benefits including improved safety and efficiency, reduced surgical equipment use, creation of smaller bone conduits, decreased cost, and decreased potential for bone injury. Though there are a few studies to support its safety and efficacy in the shoulder,[6,11] there are no studies that evaluate its use in the greater trochanter (such as during abductor, capsular, or short external rotator repair about the hip). The specific aims of this cadaveric biomechanical study were to evaluate (1) the axial force reduction of suture passage with the use of electrocautery when applied to the greater trochanter of the femur, (2) the temperature change caused while using electrocautery for suture passage, and (3) the failure loads and failure modes of this technique. The authors hypothesized that utilizing electrocautery on a needle provides a significant decrease in the force required for suture passage through the bone.

METHODS

This was a cadaveric biomechanical study. Approval for this study was obtained from our institute research committee, and the cadaveric femur specimens were procured from our institution-approved tissue supplier.

Specimens. Five fresh frozen, non-preserved lower torsi with bilaterally intact femurs were obtained and used (2 female, 3 males, 10 femurs); the mean donor age was 76 ± 8 years (range: 63 – 81 years) and the mean body mass index (BMI) was 19.3 ± 4.9 kg/m^2 (range: 13.9 – 25.7 kg/m^2). All specimens were directly and radiographically inspected and confirmed to be free of fracture, hardware, previous surgery, and other obvious gross pathology or deformity. The hip abductor muscles (gluteus medius, gluteus minimus, and tensor fasciae latae) were grossly

intact in all specimens and there was no obvious hip pathology noted. After thawing each specimen to room temperature, the specimens were dissected proximally to reveal the greater and lesser trochanters of the femurs.

Study Groups. Each pair of femurs of the same cadaver were randomly assigned to two study groups: with electrocautery on needle (study group) or without electrocautery on needle (control group). Every effort was made to replicate the *in vivo* methods of a typical hip abductor repair technique during hip arthroplasty or open hip abductor repair by simulating typical tunnel placement and trajectory. The tunnel sites were cleared of soft tissues, blood, and fluids to provide good electrical conduction through the needle. For the study group, needle penetration testing was accomplished with an electrical current applied to the needle. The electrical power from the electrocautery device (Valleylab FT10 Energy Platform, Medtronic Covidien, Minneapolis, MN) was applied to the needle using the pure "cut" function at a power setting of 50 Watts. This power setting was chosen based on the findings of previous studies and is a commonly used setting.[6,11] For the control group, needle penetration testing was performed similar to the study group except without any electrical current applied to the needle.

Experimental Setup. The experimental setup and test protocol were similar to previously described in the literature for consistency.[6,11] A custom-designed testing apparatus was designed and used to stabilize the specimens and standardize the testing procedure for conducting needle penetration (Figure 1) and failure mode testing (Figure 2a). An electrocautery grounding pad was placed onto the adjacent intact skin and soft tissues of the distal femurs to provide a closed loop for the electrocautery device. A servo-hydraulic materials testing system (Model 8874; Instron, Norwood, MA) with a 1-kN load cell was used for all needle penetration and load-to-failure testing for both groups. Two bicortical osseous tunnels were made similar to the standard open surgical techniques for hip abductor tendon repair (T1 and T2) separated by 1 cm in the vertical and horizontal planes and centered at the midline of the greater trochanter around the insertion of the gluteus medius tendon (Figure 2b). The suture (Loop 1) was passed through proximal osseous tunnels (T1), and the suture (Loop 2) was passed through distal osseous tunnels (T2). Both loops were tied with five square knots.

Figure 1. Needle penetration test experimental setup.

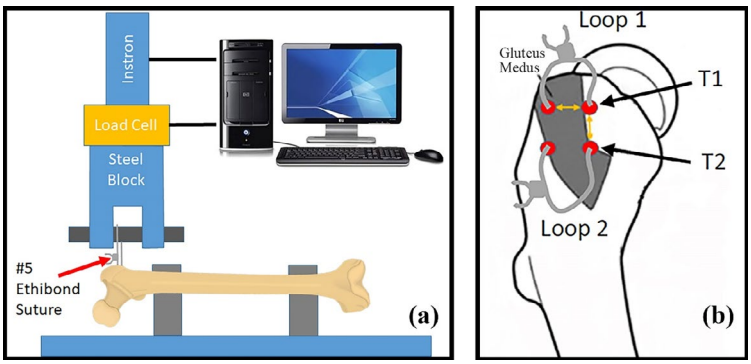

Figure 2. Failure mode test experimental setup. (a) Single load-to-failure mode test experimental setup, and (b) needle passage locations in the greater trochanter. The two osseous tunnels (T1, T2) were separated by 1 cm in vertical and horizontal planes and centered at the midline of the greater trochanter around the insertion of the gluteus medius tendon. Two suture loops (loop 1 and loop 2, as indicated in gray) were tied with five square knots and used for the load-to-failure test.

Test Protocol. Each specimen from both study groups were sequentially tested in two parts. In Part I, a needle penetration test was performed through the greater trochanter to measure peak axial force and temperature change through each cortex of the two tunnels. Peak axial force was defined as the maximum force recorded during needle penetration through each cortex. In Part II, a single load-to-failure test was performed of each suture loop (Loop 1 and Loop 2).

In part I, a #5 Ethibond® suture with a straight needle (Ethibond Excel, D7809, Ethicon Inc., Somerville, NJ) was used. The needle was preloaded to 6 N to provide a well-defined starting point for data collection. The needle was then continuously loaded at a crosshead speed of 1 mm/sec until complete needle penetration occurred through both cortices. Load and displacement data were collected at 100 Hz. For the control group, needle penetration testing was accomplished as described without an electrical current applied through the needle. For the study group, needle penetration testing was conducted the same as the control group, except the tip of the electrocautery pen was used to apply an electrical current to the needle throughout the duration of each trial. The maximum temperature was measured at the needle penetration site using a 12:1 infrared laser thermometer with an accuracy rating of 0.1°C (IR12; Ames Instruments, Calabasas, CA) held at 30.5 cm (1 foot) from the needle.

In Part II, a single load-to-failure test of the suture loops was performed to evaluate the ultimate failure loads and failure modes while using this technique. The suture loops were preloaded to 6 N to provide a well-defined starting point for data collection, and then five preconditioned loading cycles were applied from 6 N to 30 N at 1 Hz to avoid potential errors produced from slack in the loops and stretching of the suture materials. The loops were then continuously loaded at a crosshead speed of 1 mm/sec until complete bone or suture failure occurred. Load and displacement data were collected at 100 Hz, and the mode of failure was recorded. This study defined two modes of failure: 1) suture breakage or knot failure, and 2) bone tunnel failure.

Statistical Analysis. A paired-sample t-test was used to compare notable differences between groups regarding peak force, temperature, and ultimate failure load variables. Frequencies and percentages for other variables were obtained. All statistical testing were analyzed using IBM SPSS statistics software (Version 24.0; IBM Corporation, Armonk, NY), and statistically significant relationships were

defined as those p value less than 0.05.

RESULTS

Part I – Needle Penetration Peak Force Test. For the near cortex, the peak axial force was lower in only four out of ten (40%) trials in the study group compared to the control group (reduction range: 1% - 36%). On average, the peak axial force was higher in the study group compared with the control group for the near cortex of both osseous tunnels (T1: +61%; T2: +16%), although these findings were not significant (T1: p = 0.255; T2: p = 0.805; Table 1). When comparing the two tunnels at the near cortex, the study group showed no significant decrease in peak axial force, registering a 38% reduction compared to the control group (p = 0.542; Table 1).

Table 1. Summary data for needle penetration peak force test.

Cortex	Osseous Tunnel	Study Group (N) (mean ± SD, range)	Control Group (N) (mean ± SD, range)	Study vs Control Group (%)	p value	p value
Near	T1	23 ± 21 (6 – 52)	13 ± 8 (6 – 27)	61	0.255	0.542
	T2	46 ± 21 (20 – 64)	48 ± 34 (12 – 98)	16	0.805	
Far	T1	56 ± 22 (26 – 77)	63 ± 35 (31 – 118)	-2	0.593	0.463
	T2	79 ± 32 (45 – 125)	89 ± 30 (57 – 124)	-1	0.639	

Note: SD, standard deviation.

For the far cortex, the peak axial force was lower in seven out of the ten (70%) trials in the study group compared to the control group (reduction range: 11% - 51%). On average, the peak axial force was lower in the study group compared with the control group for the far cortex of both osseous tunnels (T1: -2%; T2: -1%), but these findings were also not significant (T1: p = 0.593; T2: p = 0.639). When comparing the two tunnels at the far cortex, there was no significant decrease in peak axial force in the study group of -2% compared to the control group (p = 0.463; Table 1). When comparing the peak axial force of the near and far cortex, the average peak force was significantly higher in the far cortex (range: 73% - 368%) for both study groups and for both osseous tunnels in all except one case (Table 2). In that one case, the far cortex still had a 73% higher peak force at the far cortex compared to the near cortex, although it did not reach statistical significance.

Table 2. Comparison of average needle penetration peak force (N) for near and far cortex.

Osseous Tunnel	Group	Near Cortex (N) (mean ± SD)	Far Cortex (N) (mean ± SD)	Near to Far Cortex (%)	P value
T1	Study	23 ± 21	56 ± 22	142	0.007*
	Control	13 ± 8	63 ± 35	368	0.017*
T2	Study	46 ± 21	79 ± 32	73	0.163
	Control	48 ± 34	89 ± 30	86	0.002*
T1 + T2	Study	35 ± 23	68 ± 76	96	0.008*
	Control	31 ± 30	76 ± 34	147	<0.001*

Note: SD, standard deviation.
*Significant rise in needle penetration peak force between cortices.

In the study group, there was a mean increase of 0.2°C ± 0.4°C (range: 0.0°C – 1.3°C) at the bone tunnel site with the use of electrocautery. This change in temperature difference between the two groups was not statistically significant (p = 0.435).

Part II – Load-to-Failure Test. During load-to-failure testing, 90% of the samples experienced bone tunnel failure for the study group compared to 70% in the control group (Table 3), and 50% of the trials in the study group had lower ultimate failure loads compared with the control group (reduction range: 17% - 69%; Table 3). There was no statistically significant difference detected in the ultimate failure load between either the loop tested (Loop 1: p = 0.74; Loop 2: p = 0.62) or between the two study groups (p = 0.51; Table 3). Even though the average ultimate failure load for the study group (T1: 156 N ± 34 N; T2: 169 N ± 85 N; T1 + T2: 163 N ± 61 N) was lower than the control group (T1: 167 N ± 63 N; T2: 200 N ± 76 N; T1 + T2: 183 N ± 68 N; range: 6% - 15%), these findings were not statistically significant (T1: p = 0.738, T2: p = 0.616, T1 + T2: p = 0.510; Table 3).

Table 3. Summary data for load-to-failure test.

Suture Loop	Specimen Number (lower torso)	Failure Mode		Ultimate Failure Load				
		Study group	Control group	Study group (N)	Control group (N)	Study vs Control group (%)	p value	
Loop 1	1	BT	BT	166	165	1	0.738	0.510
	2	BT	BT	100	156	-36*		
	3	BT	S	188	254	-26*		
	4	BT	BT	151	181	-17*		
	5	BT	BT	176	78	126		
Loop 2	1	BT	S	78	254	-69*	0.616	
	2	BT	BT	124	106	17		
	3	S	BT	279	223	25		
	4	BT	S	128	281	-54*		
	5	BT	BT	238	136	75		

Note: BT, bone tunnel failure. S, suture breakage or knot failure.
*Significant reduction in ultimate failure load between groups.

DISCUSSION

Utilizing electrocautery to facilitate the passage of a suture needle through bone has been described in the literature as an alternate technique to save time, operative resources, and cost.[6,11] This is the first known published cadaveric biomechanical study to simulate *in vivo* conditions for osseous bone tunnel creation through the greater trochanter utilizing this technique and provides biomechanical data with direct and immediate clinical implications. Despite prior studies supporting the use of electrocautery for suture passage in the shoulder,[6,11] the current study reveals that this technique does not significantly reduce the peak force required to pass a needle directly through the greater trochanter. This study also concluded there was no significant increase in temperature

with the use of electrocautery. There was no statistically significant difference detected in the ultimate failure load or failure mechanism of the bone tunnels between with and without electrocautery on needle repair techniques, despite concerns about the effect of electrical current passing through bone.

A biomechanical study performed by Littlefield et al.[6] identified a 48% average reduction in peak axial force to pass a suture needle through bone using this technique. Their experimental model consisted of 96 trials (72 with electrocautery and 24 without electrocautery) where a needle was passed repeatedly through a cadaveric humeral head. A humeral head was selected for biomechanical testing due to its suitability for consistent thickness and density, which is ideal for testing purposes. However, it's essential to note that this may not precisely mirror real clinical scenarios where this technique might be applied. Our previous study[11] published the first cadaveric biomechanical study that evaluated this technique applied to rotator cuff repair. The findings from that study concluded that suture passage using electrocautery significantly reduces the peak force required to pass a needle directly through the greater tuberosity. The goal with the present study aimed to address this gap in the literature to determine if electrocautery suture passage is a useful technique when applied to osseous bone tunnel creation through the greater trochanter.

The results of this study showed that electrocautery decreased the peak axial force to pass through only 40% of the trials through the near cortex of the greater trochanter (reduction range: 1%-36%), and through 70% of trials through the far cortex (reduction range: 11%-51%). Interestingly, 60% of the trials through the near cortex and 30% of the trials through the far cortex showed an increase in peak axial force with the use of electrocautery. This is in contrast to the Littlefield et al.[6] and Staggers et al.[11] studies that seemed to show a consistent and predictable decrease in peak axial force when using electrocautery. There are multiple possible explanations for this finding. Singh et al.[12] found that the electrical properties of bone to depend highly on variables such as water content, temperature, electrical frequency, power of hydrogen (pH), and direction of current, which are likely different between these two studies. Additionally, this study hypothesized that most of the variability in current testing was secondary to variable thickness in cortical bone surrounding the greater trochanter. While this variability makes it challenging to obtain consistent data, it also more accurately reflects real world conditions. As a result, this variable thickness in cortical density would make it difficult consistently to rely on this technique to pass suture through bone during osseous bone tunnel creation through the greater trochanter.

Another observation of this study was the significant increase in peak force to penetrate the far cortex when compared to the near cortex. This is likely due to the cumulative friction force or hoop stress from the near cortex acting on the needle as it passes into the far cortex. As the needle passes through each cortex of bone, there is an increase in the contact surface area of the bone on the needle, which increases resistance. This is important in hip abductor repair because using suture tunnels requires bicortical fixation through a transosseous tunnel technique. A surgeon may have difficulty or fail to pass a suture needle bicortically by hand even using the mechanical advantage from a needle driver and electrocautery. The peak axial force required to pass suture in this study exceeded upwards of 125 N of force even with electrocautery. This is a considerable amount of force, which could result in failure to pass the needle, slippage, injury, or needle breakage.

One of the potential drawbacks of using electrocautery to facilitate suture needle passage through bone was the possibility of burning the bone and affecting the structural integrity of the bony tunnel.[6] This study found that the tunnel integrity was not affected by this technique, as there was no evidence of burned tissues and the mean change of the maximum temperature was less than 2°C between the two groups. Additionally, there was no significant difference in the ultimate load to failure testing between study and control groups. This study concludes that differences in bone tunnel strength were more dependent on bone density, cortical thickness, patient age, and tunnel placement.

This study has several limitations to recognize. First, this study utilized fresh frozen cadaveric specimens, and freeze and thaw cycles of specimens over the study period could have compromised the structural quality of the cortical bone. However, every effort was made to minimize the number of freeze/thaw cycles that the specimens endured. Second, a potential confounding variable is the bone quality of the cadaveric specimens. No medical history of the cadavers was provided, though radiographic evaluation did not show abnormalities indicating osteoporosis such as increased radiolucency or cortical thinning. The authors recognize that bone mineral density evaluation was not performed in the current study and could be considered in future studies. This cadaveric study provided no information about long-term outcomes or healing biology, and the utility of this technique may differ from in vivo situation where blood, surrounding soft tissues, and other variables could affect results. This study used straight needles through perpendicular trajectories to the cortical bone, which differs from common surgical practice that often utilizes curved needles on angled trajectories. This is due to limitations of our servo-hydraulic testing system, which required linear trajectories perpendicular to the cortical bone. This study only performed a single load-to-failure test, but the leading source of failure in orthopaedic repairs has been recognized as cyclic loading. Further evaluations including actual hip abductor or analogue tissue, increased sample size with accounting for variations in bone quality, use of curved needles to simulate real clinical scenarios, and in a larger randomized controlled study is required to support the findings of this study.

CONCLUSIONS

Suture passage using electrocautery does not significantly decrease the peak force needed to pass a needle directly through the greater trochanter. This finding contradicts previous biomechanical studies showing the technique's clinical efficacy in the shoulder,[6,11] and therefore is not a reliable technique to utilize during osseous bone tunnel creation through the greater trochanter. This study hypothesized the decrease in efficacy was due to the increased variability in cortical bone thickness surrounding the greater trochanter. Clinicians should recognize these

limitations and be cautious when utilizing this technique for repairing hip abductor tendons to the greater trochanter, though there may be other clinical situations this technique might be useful.

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Keywords: electrocoagulation; femur; suture techniques; biomechanical phenomena.

KANSAS JOURNAL of MEDICINE

Brief Report

Short and Long-Term Success of a Surgery Residency Prep Course

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Received April 12, 2023; Accepted for publication Dec. 6, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.20090

ABSTRACT

Introduction. This study aimed to assess the feasibility of evaluating the short-term and long-term effectiveness of a surgery residency prep course throughout the intern year.

Methods. The authors offered a surgery residency prep course to graduating medical students. We used an anonymous survey to assess the perceived confidence in medical knowledge, clinical skills and surgical skills pre-course, post-course, and at six months into residency. Participants also completed a pre- and post-course quiz.

Results. Eleven students completed the course and participated in a pre-course survey, seven completed the post-course survey, and four completed the six month survey. Students felt significantly more confident for intern year following the course compared to before the course (4.0 vs. 2.7, p = 0.018). There was no significant change in perceived confidence at six months compared to post-course results (4.0 vs. 3.9, p = 0.197). Objectively, there was a significant improvement in post-course quiz results compared to pre-course quiz results (12.9 vs. 10.6, p = 0.004).

Conclusions. This study demonstrates that a surgery prep course may have long-term positive effects on resident confidence when entering a surgery residency. ***Kans J Med 2023;16:321-323***

INTRODUCTION

Every summer, training hospitals and medical colleges transition responsibilities and expectations to a new set of individuals. During this transitional period, interns are expected to proficiently examine patients, formulate plans, write orders, and perform life-saving bedside maneuvers. While most of these individuals will have upper-level resident or attending oversight, the oversight can be variable and may not be immediate. Certainly, this can create stressful environments for all training levels involved. Findings from a prior study show that surgical interns report feeling under-prepared to fulfill the expected responsibilities pertaining to patient care and medical knowledge.[1] Some programs have worked to ease the transition of responsibilities and instill confidence in interns through preparatory courses offered before the start of the intern year, with the goal of moderating the learning curve.[2] Resident confidence is multifactorial and includes personal experiences, individual skill development, and feedback,[3] so it is useful to have courses that vary in what topics are included. Most courses include a variety of skills, didactics, and mock scenarios. Multiple studies have demonstrated the feasibility and effectiveness of such preparatory courses.[4-8] However, these studies often lack sufficient follow-up to assess any lasting effects. In the Antonoff study,[8] course graduates were followed two months into their intern year, but were not followed past that time. Our study aimed to pilot the feasibility of assessing and comparing the short-term and long-term subjective and objective effectiveness of a residency prep course on surgical interns throughout a significant portion of their intern year.

METHODS

Our study involved assessing course participants' perceived confidence prior to, immediately following, and six months after completing a two-week surgery residency prep course. Participants in the elective course were graduating fourth-year medical students entering a surgical or surgery-related specialty. The course finished in May 2021 and the students' residencies began in July 2021. The course was designed based on the curriculum provided by the American College of Surgeons (ACS), Association of Program Directors in Surgery (APDS), and the Association for Surgical Education (ASE) Resident Prep Curriculum, with additional modifications to align with the specific resources available at our institution. The two-week course had three main categories of content: clinical skills, medical knowledge, and surgical skills. The study participants also completed a pre-course test and a post-course test over material covered in the course.

Using a multidisciplinary approach, course instructors came from various hospital training backgrounds and included pharmacists, respiratory therapists, surgical technologists, wound care nurses, anesthesiologists, surgical residents, and surgical attendings. IResearchers organized the course content following the model established by Winter et al.4, delivering didactic lectures for clinical skills and medical knowledge topics, and providing hands-on workshops in either a surgical skills lab or simulation center for the surgical skills components.

The Ascension Via Christi Hospitals Wichita IRB and University of Kansas Medical Center IRB approved the study before its commencement. Participating students enrolled in the Spring 2021 course received a "Pre-Course Survey" to list three topics of most interest and three topics of least confidence. Students were then asked to use the Likert scale (1 = poor, 2 = fair, 3 = okay, 4 = good, 5 = very good) to rank their confidence in 16 different areas. Participants completed a pre-test which consisted of 15 multiple-choice questions related to surgical knowledge (see Appendix; appendix is available online at journals.ku.edu/kjm). A post-test with the same 15 multiple-choice questions was administered upon completion of the course. In December 2021, six months into residency, a similar, "Six-Month Follow-Up Survey" was sent to study participants. This final survey asked the same Likert-scale questions regarding confidence level in each of the 16 areas previously assessed.

Data Analysis. Investigators evaluated changes in confidence levels among study participants using a Wilcoxon signed-rank test, with individual assessments conducted for each area within surgical skills, medical knowledge, and clinical skills. Indexes were created to assess the pre-, post-, and six-month course survey confidence level within each category. Pre- and post-test scores were compared as means. All analyses were conducted using SPSS release 19.0 (IBM Corp., Armonk, NY).

RESULTS

Study participants (N = 11) reported three areas of most interest and least confidence in a pre-course survey. All 11 participants completed the pre-course survey. The two most frequently noted areas of interest were "line access" and "chest tube insertion." The two most reported areas of least confidence were writing orders and ventilator management.

We had 7 of 11 participants complete the post-course survey (63.6% response rate). Nearly every category that measured the participants perceived confidence improved by the end of the course (Table 1). Overall, mean confidence score rose from 2.7 to 4.0 (p = 0.018). Table 2 breaks down reported confidence scores in each course category and demonstrates that participants gained far more confidence in their clinical skills and procedural based skills compared to their medical knowledge. Significant improvement in confidence scores was seen in all three clinical skills areas, and in six of eight of the surgical skills areas. There was significant improvement in only two of five of the medical knowledge skills. Not only did perceived confidence improve, but overall competence also increased, as measured with a pre- and post-test of surgical knowledge. Pre-test scores averaged 71% correct, while post-test scores averaged 86% correct (p = 0.004).

Table 1. Wilcoxon signed-rank test of pre- and post-course surveys.

Survey	N	Mean	Std. Deviation	Min.	Max.
Pre-course	11	2.7	0.4	2.1	3.3
Post-course	7	4.0	0.6	3.0	4.6

Z = -2.366, p = 0.018.

Table 2. Wilcoxon signed-rank test comparison of pre- and post-course surveys per category (N = 7).

Category	Pre-Course Mean (SD)	Post-Course Mean (SD)	P value
Clinical skills			
Dictating	2.6 ± 1.0	3.4 ± 0.5	0.045
Writing orders	2.1 ± 0.7	4.0 ± 0.6	0.007
Answering pages	2.1 ± 0.7	4.0 ± 0.6	0.002
Medical knowledge			
Pharmacy: Anticoagulants/ reversal	3.0 ± 0.6	3.4 ± 0.8	0.200
Pharmacy: Pressors and sedation	2.4 ± 1.0	3.3 ± 0.8	0.143
Pharmacy: Electrolytes	3.4 ± 0.6	3.7 ± 1.0	0.457
Radiology interpretation	2.9 ± 0.9	3.7 ± 1.0	0.045
Mechanical ventilation	1.9 ± 0.7	3.3 ± 1.0	0.025
Surgical skills			
Sterile technique - Set up	4.3 ± 0.8	4.7 ± 0.8	0.289
Wound care/wound vacs	3.1 ± 0.4	3.7 ± 0.5	0.103
Punch biopsies	3.7 ± 0.5	4.7 ± 0.5	0.004
Line access	2.4 ± 1.3	4.4 ± 0.7	0.007
Chest tube insertion	2.1 ± 0.7	4.4 ± 0.7	<0.001
Suturing/knot tying	4.0 ± 0.8	4.7 ± 0.5	0.008
Endoscopy	2.1 ± 0.9	4.00 ± 1.2	0.015
Anastomoses	1.9 ± 0.9	4.1 ± 0.9	<0.001

The six-month follow-up survey again asked participants to rate their perceived confidence. Only 4 of the 11 course participants responded (36.4% response rate). The overall mean confidence scores of the respondents at the six-month follow-up was compared to the post-course survey (3.9 and 4.0, respectively; p = 0.197). Table 3 reflects the confidence scores individuals had at post-course and at six months follow-up. Confidence levels were remarkably similar between the two groups.

Table 3. Wilcoxon signed-rank test comparison of post-course and six-month follow-up surveys per category (N = 7).

Category	Post-Course Mean (SD)	Six-Month Follow-Up Mean (SD)	P value
Clinical skills			
Dictating	3.5 ± 0.6	3.8 ± 1.0.	0.391
Writing orders	4.0 ± 0.0	4.5 ± 0.6	0.182
Answering pages	4.0 ± 0.0	4.8 ± 0.5	0.058
Medical knowledge			
Pharmacy: Anticoagulants/ reversal	3.3 ± 1.0	3.0 ± 0.8	0.391
Pharmacy: Pressors and sedation	3.0 ± 0.8	3.0 ± 0.8	
Pharmacy: Electrolytes	4.0 ± 0.8	4.3 ± 0.5	0.391
Radiology interpretation	3.8 ± 1.3	3.8 ± 1.3	
Mechanical ventilation	3.3 ± 0.5	3.3 ± 1.3	1.000
Surgical skills			
Sterile technique - Set up	5.0 ± 0.0	4.8 ± 0.5	0.391
Wound care/wound vacs	4.0 ± 0.0	4.5 ± 0.6	0.182
Punch biopsies	4.8 ± 0.5	5.0 ± 0.0	0.391
Line access	4.3 ± 0.5	3.8 ± 0.5	0.182
Chest tube insertion	4.3 ± 0.5	3.5 ± 1.0	0.215
Suturing/knot tying	4.8 ± 0.5	4.8 ± 0.5	
Endoscopy	4.0 ± 0.8	3.3 ± 0.5	0.058
Anastomoses	4.0 ± 0.8	2.5 ± 1.3	0.014

DISCUSSION

Our findings demonstrate the value of a residency prep course and its insight regarding the long-term effects of surgical skills training. While prior studies have looked at the immediate effect surgery prep courses offer,[1,4-8] very few have evaluated outcomes at time points into their residency[6,8] and none have followed six-months into residency. Our study provides data on the confidence retained after six months; however, it is significantly limited by its small sample size, singular year of study, lack of a control group, and poor retention of survey participants. To gain a deeper understanding of the implications of a surgery prep-course, additional studies with larger sample sizes are needed. It would also be interesting to know if these courses can provide a clinical benefit by asking upper-level residents or attendings to rate the intern's skill level. However, we should not overlook the importance of moderating

the learning curve. It is more likely that a prep-course can demonstrate to the trainee the attainability of such skills and improve their ability to learn in the first few months of residency. These prep courses are designed to supplement a training program where skills and knowledge will be further refined.

Seven of the eleven study participants completed the post-course survey, and their overall confidence level reflected a significant increase over the duration of the course. This result aligns with previous research by Winter et al.,[4] demonstrating that participants enhanced their overall confidence, with a median score increasing from 2.4 pre-course to 3.8 post-course. The long-term effects of a prep course were assessed with a six-month follow-up survey which again assessed the participants perceived confidence. We had poor retention of respondents with only four of the original 11 participants responding. Their perceived confidence remained stable and suggests the course may have long-term benefits. However, the retention of the perceived confidence cannot be definitively attributed to the prep course as these individuals did have an additional six months of training and were not compared to a control group.

In addition to the reported confidence, clinical knowledge showed improvement. What is not known is how well this improvement in knowledge and confidence translates to better clinical preparation during residency. Future studies should incorporate the opinions of clinical educators or residency program directors on the clinical skills of residents who attend a pre-residency surgical prep course.

While this course has been offered for several years at our institution, our study is limited to data from the 2021 course. It would be beneficial to have multiple years and far more study participants to further investigate the long-term benefits of a surgery prep course. The study also is limited by its small sample size, lack of a control group, and poor retention of survey participants.

CONCLUSIONS

Our study provides some insight on the long-term efficacy a surgery prep course may have on incoming interns. Perceived confidence appears to be retained at six months although confidence does not appear to continue growing over this time. The study objectively showed that overall knowledge increased as a result of completing a surgery prep course. However, it is still unclear how far into residency a surgery prep course can provide an educational advantage. Further studies using larger sample sizes with the addition of a comparative measure of clinical skill are needed to definitively evaluate the long-term effects of a surgery prep course.

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Keywords: activities, educational, surgical procedures, internship and residency, clinical competence

KANSAS JOURNAL of MEDICINE

Brief Report

Moral Injury Among Transplant Providers: Evaluating the Effects of Training in End-of-Life Counseling

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Received July 24, 2023; Accepted for publication Dec. 11, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.21171

ABSTRACT

Introduction. Ethical issues are pervasive in healthcare, but few specialties rival the moral complexity of transplant medicine. Transplant providers must regularly inform patients that they are no longer eligible to receive a potentially life-saving operation and the stress of these conversations poses a high risk of moral injury. Training in end-of-life counseling (EOLC) has proven to significantly reduce provider stress and burnout. The purpose of this study was to determine whether training in EOLC reduces levels of moral injury among transplant providers.

Methods. This was a mixed methods study. We interviewed 10 patient participants and administered a survey to staff in the solid organ transplant department at the University of Kansas Health System. Respondents indicated whether they had received training in EOLC and completed the standardized Moral Injury Symptom Scale-Healthcare Professionals version (MISS-HP). A two-sample, one-sided t-test compared levels of moral injury between trained and untrained staff. Subsequently, we conducted semi-structured interviews with transplant providers, then performed inductive coding followed by thematic network analysis.

Results. Thirty-seven percent (14/38) of respondents reported a moral injury score at or above the threshold for psychosocial dysfunction associated with moral injury. Analysis revealed no difference in moral injury scores between the trained and untrained groups ($p = 0.362$, power $(1-\beta) = 0.842$). Thematic network analysis demonstrated high-level themes of "challenges", "training", and "stress relief".

Conclusions. Our study demonstrated a concerning prevalence of moral injury among transplant staff and suggested that EOLC training did not significantly mitigate the threat of moral injury.

Kans J Med 2023;16:324-327

INTRODUCTION

Ethical issues exist in all fields of healthcare; however, few specialties rival transplant medicine in terms of moral complexity and emotional strain. Notwithstanding recent advances in xenotransplantation,[1] transplant surgery remains primarily dependent on human organ donation and the allocation of a scarce, life-saving resource. Despite the best efforts of the medical community in the United States, approximately 6,200 patients die annually while awaiting an organ.[2] Thousands more are deactivated from the waitlist for various reasons, including physical decline, making transplant survival unlikely.[3] Transplant providers regularly engage in end of life conversations with patients and, in the absence of appropriate support, are at high risk of moral injury.

Moral injury is a concept created to describe the effects of wartime stress on military personnel. It has been defined as "perpetrating, failing to prevent, or bearing witness to acts that transgress deeply held moral beliefs and expectations."[4] In recent years, moral injury has emerged as a subject of discussion in healthcare contexts. Although physician distress has frequently been described using terms such as workplace stress or burnout, scholars have recently argued that moral injury may be a more appropriate term, as it encompasses the ethical, and even existential, challenges faced by providers caring for patients with terminal illness.[4]

The breaking of bad news is an acute stressor in all specialties and poses a substantial risk of physician distress.[5] One potential means of mitigating moral injury is to provide training in end-of-life counseling (EOLC). Training to improve communication skills is among the most effective ways to reduce physician stress.[3,6] Historically, training in breaking bad news has been neglected in medical curricula, and as recently as 2014, the majority of clinicians reported that they had not received formal training in holding difficult patient conversations.[7] The purpose of this study was to determine whether training in EOLC reduces levels of moral injury among transplant providers.

METHODS

We utilized a mixed methods approach in this study, which was approved by the University of Kansas Medical Center Institutional Review Board. We administered a survey consisting of closed-ended questions to staff working in the solid organ transplant department at the University of Kansas Health System (UKHS) in Kansas City. Physicians, nurses, social workers, and chaplains received the survey because they played a role in direct patient care. Study data were collected and managed using REDCap®, an electronic data capture tool hosted at the University of Kansas Medical Center.[8,9] Written informed consent was obtained from subjects prior to beginning the survey.

The survey evaluated the level of EOLC training respondents had received and administered the Moral Injury Symptoms Scale – Healthcare Professionals version (MISS-HP), a standardized tool in the literature designed to quantify moral injury.[10] The MISS-HP contains a mix of positively and negatively worded items to reduce response bias, and it has a strong evidence base in the literature.[10-14] We stored responses in a secure REDCap® drive, accessible only to IRB-approved study members, to ensure anonymity.

A two-sample, one-sided t-test compared levels of moral injury between participants who had received EOLC training and those who had not. A one-sided t-test evaluated whether moral injury levels were lower among staff members who received training in EOLC. We used Microsoft Excel® to analyze quantitative data.

Following survey administration, we conducted semi-structured interviews with respondents who indicated an interest in further discussion. The same facilitator conducted all interviews individually. An interview guide of four questions, based on themes in the literature, elicited elaboration on survey responses. The interview guide's

finalization considered feedback from Jody Olson, M.D., who previously served on the liver transplant team at UKHS.

Participants answered questions about the greatest challenges in telling a patient that they were no longer eligible for transplant, the most challenging questions they had been asked by a patient, whether they found their job mentally and emotionally stressful and ways in which they managed this, and in what ways they felt that training in EOLC could be improved. The interviewer recorded all interviews via Zoom and transcribed the audio recordings verbatim. We did not employ member checking for two reasons: 1) interviewees already relayed potentially distressing or traumatic experiences during the interview, and the potential value of engaging them in member checking did not outweigh the potential for harm; and 2) analysis of the qualitative data alongside analysis of the survey responses allowed us to engage in validating the qualitative data without using member checking. The first author (HD) conducted manual inductive coding of the transcripts, guided by principles of grounded theory and facilitated by NVivo.[15] The first (HD) and senior (DH) authors developed the final codebook by consensus. The first author (HD) organized the codes into a thematic network and finalized it by consensus with the co-author (DH and TR).[16]

RESULTS

Thirty-seven of the 105 people who received the survey provided a completed response, for a response rate of 34.6%. Physicians comprised 27% (10/37) of respondents, while nurses, including APRNs and nurse practitioners, represented 56.8% (21/37) and the remaining 16.2% (6/37) identified as social workers and chaplains.

Of these, 35.1% (13/37) indicated that they had received EOLC training, while 64.9% (24/37) had not. One respondent had received training during their undergraduate degree, four had been trained in graduate school, seven in post-graduate or residency programs, and 12 while on the job or through continuing medical education (we allowed multiple responses to this question on the survey). Eight participants had undergone training within the past five years, four within the last 6-10 years, and one within the last 11-15 years. Regarding training modality, nine respondents learned from a lecture-based model; three from an experiential model, including standardized patient simulations and role-playing with peers; and one indicated "other", noting that they had had a palliative care rotation during fellowship training.

On a scale of 1-100, 36.8% (14/38) reported a MISS-HP score at or above 36, the recognized threshold for higher risk of psychosocial dysfunction associated with moral injury.[10] A two-sample, one-sided t-test revealed no difference in moral injury scores between trained and untrained groups ($p = 0.300$, power = 0.842).

Ten survey respondents expressed interest in a follow-up interview. Three physicians (one transplant surgeon and two transplant hospitalists), three nurses, and four chaplains completed interviews. We identified the following primary codes: challenges, stress relief, and training, as detailed in Table 1. Interview responses are detailed in Table 2.

Table 1. Thematic network analysis of interview responses.

Primary Themes	Secondary Themes	Tertiary Themes	Number of Interviewees Expressing This Theme
Challenges	Caregiver burden	Taking work home	4
		Losing patients	3
		Powerless to help	4
	Organ allocation	Rejection for transplant	4
		Relapse	1
		Realization that someone else must die	2
	Patient communication	Difficulty accepting prognosis	2
		Giving realistic hope	5
Training	Attitudes toward EOLC training	Training is important	5
		Hard to facilitate	3
		Best to consult palliative care	3
	Areas to improve	Interdisciplinary communication	3
		Bedside manner	6
Stress relief	Interpersonal support	Community support	5
		Workplace support	7
		Seeing a therapist	2
	Personal care	Exercise	3
		Time away from work	5
		Mindfulness	6

Table 2. Prominent interview themes with illustrative quotes.

Caregiver burden	*"We create these really close, intimate relationships with [patients] and with their caregivers so we're there in the final stages when they do pass away, and it's not only the patient that passes away but then you don't have that family that you get to see any more in the clinic and you don't get to hear stories about how they're doing, so it's like losing your own family member."* (Nurse)
Organ allocation	*"I tell patients that, for you to survive, there's two people who have to die: the person who's going to give you their liver and the person that you're going to take the liver away from, who might have been a better candidate. So, I usually look at it from that way, that I have the utmost obligation to protect that gift of life, making sure that the candidate who's going to get it is well deserving of it."* (Physician)

Interpersonal support	*"I feel like the people that I work with are almost as much family to me as the people that I live in my house with, and so we share the good, the bad, the ugly, and we all lean on each other for support when something does happen."* (Nurse)
Personal care	*"I think part of it comes with learning that you can't carry everyone's burden and the memory of everything that you've done, with you. There are some things that will never leave your heart, you know, that as long as I have memory, I will remember them, and it amazes me how many things I do let go. I think that that's probably very healthy because, to be honest, those are not my things to carry, those are not my emotions to carry. I can do my part, and then I think it is appropriate to let go as much as I can."* (Chaplain)
Difficulty facilitating EOLC	*"I guess I could do a better job of bringing medical students and residents into that situation, but then that's always awkward for the families to have some person there who has nothing to do with anything, just watching them suffer. So how do you train someone how to deal with that, but not destroy the family's relationship that you have with them."* (Physician)

DISCUSSION

Over one-third of transplant staff in this study had a moral injury score at or above the threshold for risk of psychosocial dysfunction, indicating a concerning prevalence of moral injury on their transplant teams. These levels are comparable to healthcare workers caring for COVID-19 patients at the height of the pandemic; studies demonstrated a moral injury prevalence of 32.4-41% in providers caring for COVID-19 patients during lockdown,[14] compared to a pre-COVID prevalence of 23.9% among healthcare workers.[17] Our findings indicated that transplant providers are at substantial risk of moral injury and that EOLC training is likely insufficient to mitigate this threat, as respondents who had received EOLC training did not demonstrate lower moral injury scores.

Participants' interview responses suggested several reasons for this lack of significant differences. Although most respondents endorsed the benefits of EOLC training, some pointed out that effective training could be difficult to facilitate. One physician noted that the stress of breaking bad news cannot be fully replicated through standardized patient interactions or didactic lectures and that, though it was possible to bring students to witness EOLC patient encounters, it could cause distress to patients to have an additional person in the room to witness their suffering as they received difficult news. Interviewees discussed that more tangible sources of stress relief included personal care practices and time away from work, as well as community support. Workplace support stood out as a prominent source of stress relief for most respondents. Participants stated that, though they felt strongly supported by their friends and family outside of the workplace, there was a sense of comfort, camaraderie, and understanding in talking to those who shared their experiences and understood the gravity of caring for the terminally ill firsthand. Exploring the impact of team support, as well as means to cultivate a supportive workplace, could be a fruitful direction for future studies.

CONCLUSIONS

These findings suggested that transplant providers are at significant risk of moral injury based on the ethical and emotional stress posed by their specialty. Furthermore, EOLC training was shown to be insufficient to mitigate this threat to staff wellbeing. Transplant staff cited workplace support as a primary source of stress relief, but future research is needed to understand the protective effects of workplace support on moral injury.

ACKNOWLEDGEMENT

Funding for this study was provided by the Clendening and King Summer Research Fellowship Grant at the University of Kansas School of Medicine.

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Keywords: moral injury, end of life counseling, health education, transplant

Presentations: This research was previously presented at the American College of Physicians Kansas chapter meeting during the student poster session on October 27th, 2022, at the Marriot Hotel in Overland Park, Kansas.

KANSAS JOURNAL of MEDICINE

Case Report

Hold off That Olanzapine! The Development of Neuroleptic Malignant Syndrome in a Dehydrated Pediatric Patient

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Received Sept. 14, 2023; Accepted for publication Dec. 11, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.21303

INTRODUCTION

Neuroleptic Malignant Syndrome (NMS) is a rare and life-threatening complication of treatment with antipsychotic medications.[1] NMS most commonly develops from antipsychotics and other medications that interfere with dopamine transmission.[2] While typical antipsychotics like haloperidol and fluphenazine more commonly cause NMS, atypical antipsychotics such as olanzapine and aripiprazole also can precipitate this condition.[3-5] A multitude of risk factors can increase risk for NMS, including dehydration, sudden increase or withdrawal of medication, use of restraints, and exhaustion.[6-8] Its complex clinical presentation most often involves some combination of altered mental status, elevated blood pressure, tachycardia, tachypnea, muscle rigidity, and diaphoresis.[6,7] Common sequelae include cardiac arrhythmia, disseminated intravascular coagulation, and respiratory failure.[3,6] Laboratory studies often reveal elevated creatine kinase (CK) levels, myoglobinuria, leukocytosis, and elevated liver function tests.[7,9] If not recognized early, NMS may result in death.

Though well-characterized in adult populations, few reported cases of pediatric NMS exist in the literature. The following case discusses NMS developing in a severely dehydrated pediatric patient after receiving a single dose of olanzapine.

CASE REPORT

An eight-year-old male with a past medical history of autism with severely impaired expressive language, not on any medication, who came to the Emergency Department (ED) with the complaint of nausea, vomiting (non-bloody, non-bilious), and diarrhea (non-bloody) for two days. On physical exam, the patient appeared ill, pale, and fatigued. Initial labs showed an elevated white count and increased anion gap metabolic acidosis. After ruling out appendicitis with an abdominal X-ray and CT scan, the hospital physicians administered a bolus of intravenous (IV) fluids and started him on maintenance fluids, then admitted him for further management given chronic poor oral intake and dehydration.

During his stay in the ED, the patient became physically aggressive, ripping out his IV, pulling his mom's hair, biting her, and attempting to bite the nurse. He received 5 mg of olanzapine oral dissolving tablet (ODT) as a sedating measure, but he soon grew increasingly aggressive and had a dystonic reaction involving an oculogyric crisis and stiffening of his legs. The medical team transferred him to the inpatient unit to observe if he would improve with oral fluid intake.

During this time, the patient continued to have diarrhea and worsening muscle rigidity. Within a few hours, he became tachycardic and tachypneic. His mental status acutely worsened to the point of obtundation. Labs revealed severe metabolic acidosis, leukocytosis, thrombocytosis, and a critically low glucose.

Following transfer to the Pediatric Intensive Care Unit (PICU), his hypoglycemia resolved with a 5 mL/kg D10 bolus, though his acidosis worsened. Repeat laboratory studies showed lactic acid increasing from 7.5 to 9.3, as well as a CK of 12,039. Elevated INR and transaminitis prompted a workup for acute liver failure that did not elucidate a specific cause; likewise, blood cultures demonstrated no growth of any microorganisms, and a head CT was unremarkable. Extensive genetic testing did not reveal any diseases of metabolism. Excluding these other causes indicated that NMS secondary to olanzapine likely caused his clinical deterioration.

He received sodium bicarbonate to correct his acidosis, an empiric dose of vancomycin and ceftriaxone, as well as Vitamin K, Rifaximin, and emergent plasma exchange. His hypotension required three vasopressors (epinephrine, norepinephrine, and vasopressin) to correct. After three days in the PICU, he achieved medical stability. Discharge occurred after one week of hospital stay.

DISCUSSION

NMS is a fatal complication that most commonly happens after initiating antipsychotic medications, taking anywhere from a few hours to weeks to develop.[6,10] Increased dopaminergic D2 receptor antagonism in the central nervous system creates a series of dysregulated homeostatic responses like fever, altered mental status, and muscular rigidity.[8]

Prior studies have noted that dehydration can predispose towards NMS.[6-8,11] In one case, a two-year-old girl presenting with nausea, vomiting, and dehydration received high-dose metoclopramide (dopamine D2 receptor antagonist) and developed NMS within two hours.[10] In another, a six-year-old girl with dehydration developed NMS after receiving the typical antipsychotic thioridazine.[12]

Our eight-year-old patient received a single 5 mg dose of olanzapine for acute agitation. After this, the patient developed tachycardia, tachypnea, altered mental status, and muscle rigidity, classic symptoms of NMS. Furthermore, our patient exhibited increased CK levels and leukocytosis, important diagnostic features of NMS, as well as characteristic electrolyte abnormalities, increased anion gap metabolic acidosis, acute kidney injury, acute liver failure, hypotension, and coagulopathy.[1,4,6,7,13,14]

During episodes of acute agitation, pediatric patients can receive three classes of medications: antihistamines, benzodiazepines, and atypical antipsychotics.[15] Though the FDA only has approved risperidone and aripiprazole for irritability in patients with autism, many EDs administer olanzapine to pediatric patients who exhibit such severe agitation that they pose a danger to themselves or others, as occurred in this case.[16,17] However, while 5 mg of olanzapine is a reasonable dose for acute agitation in most individuals, it triggered NMS in this antipsychotic-naïve, underweight, and severely dehydrated patient. It is vital to assess for environmental risk factors on a case-by-case basis before prescribing antipsychotic medications to reduce risk for this potentially deadly sequela.

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Keywords: Neuroleptic Malignant Syndrome, autism, agitation, dehydration, antipsychotics

KANSAS JOURNAL of MEDICINE

Case Report

Common Post-Viral Sequalae: Onychomadesis in Setting of Giannoti Crosti Syndrome

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Received July 12, 2023; Accepted for publication Dec. 15, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.21033

INTRODUCTION

Giannotti Crosti Syndrome (GCS), also known as infantile papular acrodermatitis, is a cutaneous reaction commonly observed in pediatric populations as a response to viral infections. It is characterized by sudden eruption of papules on the face, buttocks, and extensor surfaces, typically occurring during or following a viral infection. Symptoms may include varying degrees of pruritus and systemic signs of illness, such as fever or myalgias, which usually resolve within a short period.[1,2]

The exact underlying cause of GCS remains unclear, but it is believed to involve a delayed hypersensitivity reaction to various viral infections, including Hepatitis B, Cytomegalovirus, Epstein-Barr Virus, Respiratory Syncytial Virus, and Parvovirus.[3] Moreover, a prior study has indicated that children with a history of atopic dermatitis may be more predisposed to developing GCS, suggesting a potential role of immune hypersensitivity in the pathogenesis of the disease.[4]

While children with a history of atopy may face a higher risk of developing cutaneous sequelae, GCS also can occur in otherwise healthy children, primarily affecting those aged 3 months to 15 years with most GCS cases (over 90%) being observed in children under four years old.[3] The management of GCS is relatively straightforward, with a clinical diagnosis and supportive care comprising the mainstay of treatment. In persistent cases, skin biopsies may be used to rule out other conditions, although this approach can place additional emotional and financial burdens on patients and their families. Overall, the prognosis for GCS is typically positive, as skin lesions often resolve spontaneously, with occasional complications such as hyperpigmentation.

Although cutaneous manifestations of GCS have been extensively studied, literature regarding post-viral changes in this clinical context is limited, leading to the potential of unnecessary clinical investigation or heightened anxiety. In this paper, we present a case of a pediatric patient who developed onychomadesis, characterized by the peeling of the proximal nail beds, as a sequela of Giannotti Crosti Syndrome.

CASE REPORT

A two-year-old female with a history of premature birth and umbilical hernia visited the clinic due to concerns about peeling nail beds in both hands and feet. Six weeks earlier, she had presented to the clinic with a pruritic rash following an unspecified upper respiratory infection. During the previous examination, flat-topped papules were observed in clusters along the diaper region and perioral area, with scattered papules on the arms and feet. Mild lymphadenopathy of the axillary lymph node was present, but no other signs of systemic illness such as fever, chills, or myalgias were reported. Considering the respiratory infection and the development of a rash following its resolution, a suspected diagnosis of Giannotti Crosti Syndrome was made, and supportive therapy with topical hydrocortisone and diphenhydramine was recommended.

During a subsequent visit to the clinic six weeks later, the rash had resolved, but peeling of the nail beds in both fingers and toenails was noted. The patient's mother reported that the peeling had begun two weeks prior, with no significant changes since the last visit. Physical examination revealed 1-2-millimeter indentations at the proximal end of all nails (Figure 1), with the right large toe exhibiting additional grooves proximally (Figure 2).

Figure 1. Nailbed separation of the right hand [seen prominently on ring finger].

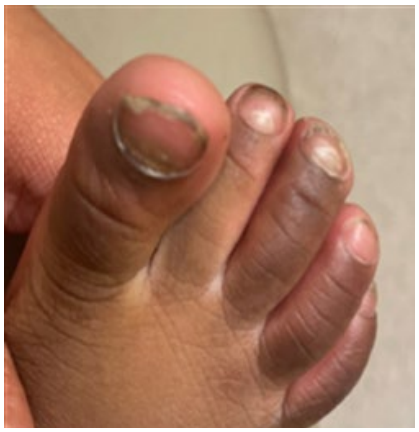

Figure 2. Nailbed separation of the right foot.

There were no signs of pain, inflammation, or fungal infection in any of the affected digits, and the patient's mother denied any concerns regarding associated symptoms. Routine blood and serum labs yielded normal results. Given negative clinical and laboratory results, the possibility of benign post-viral nail changes such as onychomadesis because of her recent episode of Giannotti Crosti Syndrome was discussed. Upon reviewing the benign etiology of this condition, a referral to pediatric dermatology was recommended, primarily for addressing cosmetic concerns.

Keywords: acrodermatitis, gianotti crosti syndrome, onychomadesis, nail disease, rash

DISCUSSION

Onychomadesis refers to the separation of the proximal nail plate and nail matrix due to a transient cessation of nail growth. Various factors can cause this clinical finding, ranging from viral infections like Hand Foot Mouth disease, severe systemic diseases, nutritional deficiencies, trauma, and fever to drug ingestion and infection.[5] While this phenomenon can be alarming, it often represents a benign consequence of an insult to the body, and the nail beds can fully regrow within 12 weeks, with faster regeneration in some children. There is no specific treatment for onychomadesis, and the recommended approach usually involves watchful waiting and monitoring for any other signs of illness, unless obvious indications of a serious condition accompany the peeling.[6]

Notably, nail bed peeling has also been associated with other infectious illnesses. For instance, a 2017 case series reported four pediatric cases of isolated onychomadesis following Hand-Foot-Mouth disease, suggesting that, in the appropriate clinical context, nail bed peeling can be a consequence of the same viral infection rather than an indication of a more serious illness.[7] This gives credence to the notion that without a laboratory or clinical finding that suggests further evaluation is needed, that these patients should solely by monitored.

While further investigations and extensive workups may provide some benefit, studies have demonstrated that a specific etiology remains unidentified in over half of the patients, without impacting the overall clinical outcome. This underscores the importance of employing clinical judgment in assessing the disease course. Given the benign and self-limiting nature of this condition in the presented case, physicians can reassure patients that nail bed changes are self-limiting, thereby reducing the need for further interventions that may lead to misdiagnosis. It is beneficial for physicians to be aware that onychomadesis can occur in various types of infections, enabling them to inform concerned parents about the possibility of its development in the weeks following the resolution of Giannotti Crosti Syndrome, as well as other types of infections.

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Case Report

Unveiling the Mystery: Correlating Physical Findings with Endoscopy to Diagnose an Uncommon Lesion

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Received July 15, 2023; Accepted for publication Dec. 18, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.21074

INTRODUCTION

Gastrointestinal (GI) bleeding poses a significant risk, even in the pediatric population, with potentially life threatening consequences.[1] This complication typically is categorized into three major forms, upper GI bleed, lower GI bleed, and bleeding of unknown origin.[1] Common causes of upper GI bleed in the pediatric population include esophagitis, ulcers, and esophageal varices, while lower GI bleeding is attributed to inflammatory bowel disease, colitis, and milk protein intolerance.[1] However, it is noteworthy that GI hemangiomas can present as an uncommon source of GI bleeding.[2] These benign vascular tumors may develop anywhere along the GI tract, with the highest incidence in the small intestines, followed by the colon and rectum.[2]

Patients with GI hemangiomas frequently exhibit GI bleeding, with symptoms such as melena and/or hematochezia. Depending on the location of the lesion in the GI tract, management may involve blood transfusion or surgical intervention. Due to its rarity, GI hemangioma is not typically considered a primary cause of GI bleeding in pediatric cases.[3] In this case report, we emphasize the significance of recognizing rectal hemangioma as a potential contributor to recurrent hematochezia, shedding light on this atypical cause of GI bleed in the pediatric population.

CASE REPORT

A 17-year-old female patient presented to the Emergency Department (ED) with bloody stools and was found to have a critical hemoglobin of 3.1 g/dL. She reported a long history of chronic intermittent blood in her stools, and had previously undergone a negative work-up, including a negative colonoscopy, esophagogastroduodenoscopy (EGD), and Meckel's scan at the age of three. The patient reported having worsening abdominal pain, vomiting, and multiple daily episodes of loose, bloody stools, along with a weight loss of 20 lbs. in the six months prior to her ED presentation. Her medications included a proton pump inhibitor and H2-blocker, which were started about one month before presentation, and a selective serotonin receptor inhibitor, which had been started about one week earlier. She was admitted to the hospital and received multiple packed red blood cell transfusions, which improved her hemoglobin to 7.3 g/dL, as well as iron dextran infusion. An abdominal X-ray showed moderate stool burden. The EGD and colonoscopy revealed gastritis and increased vascular markings in the sigmoid colon. A cutaneous lesion with bluish discoloration was found on the right buttock, raising concerns for a possible hemangioma. A Computed Tomography (CT) angiography of the abdomen and pelvis with delayed imaging was completed and showed no obvious abnormalities. The patient was then discharged home.

Multiple outpatient complete blood count tests were conducted, indicating an initial normalization of hemoglobin levels. Following this, she underwent a capsule endoscopy study and magnetic resonance imaging (MRI) of the abdomen and pelvis. However, these investigations did not identify a definitive source of bleeding, but raised concerns about the presence of hemangiomas in the right-sided and sigmoid colon. About four months later, the patient was readmitted to the hospital after she was found to have hemoglobin of 4.7 g/dL. A diagnostic laparotomy was performed, confirming the presence of a sigmoid hemangioma, as verified by histopathological examination (Figure 1). She subsequently underwent an elective, robotically assisted low anterior resection with splenic flexure mobilization, which was completed without complications.

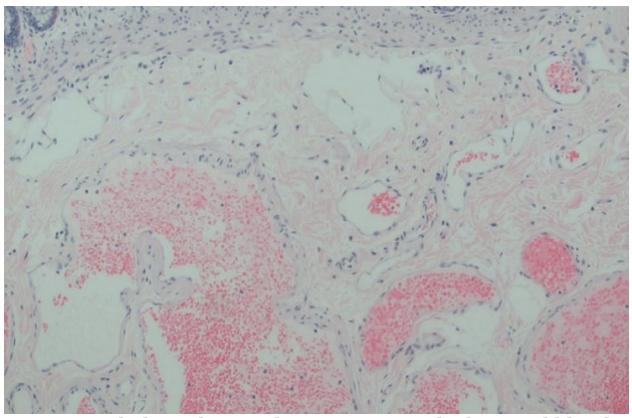

Figure 1. Histopathology showing hemangioma with abnormal blood vessels, endothelial cell proliferation, and lack of normal vessel architecture.

DISCUSSION

Gastrointestinal hemangiomas, characterized as relatively rare and benign vascular tumors, can manifest anywhere along the GI tract. with the colon and rectum being the most prevalent sites.[4] While the hallmark of GI hemangiomas often is GI bleeding, patients may present with a range of symptoms, including abdominal pain, dizziness, and generalized weakness. Histologically, GI hemangiomas are categorized into capillary, cavernous, and mixed types, with cavernous hemangioma being the most frequently observed. Solitary capillary hemangiomas, usually causing anemia through minor chronic bleeding, are common. Diagnostic tools encompass abdominal CT scans, MRI, ultrasound, and if small intestine bleeding is suspected, capsule endoscopy or nuclear medicine scintigraphy can be used. Expectant observation is typically advised for solitary, small GI hemangiomas with only mild symptoms. In cases requiring medical intervention, corticosteroids, which suppress the expression of the vascular endothelial growth factor and interferon alpha, may be employed.[5] Severe anemia and significant overt GI bleeding may necessitate transfusions. If medical management proves insufficient, surgical intervention becomes a consideration, contingent on the lesions' location.[6] The surgical technique ranges from wedge resection, antrectomy, subtotal gastrectomy or total

gastrectomy for gastric lesions, and segmental resection for small bowel lesions may require ileocecectomy, right hemicolectomy, left hemicolectomy, or segmental resection.[7] Lesions in the rectum may require a low anterior resection.[8]

This report outlines a case in which a patient presented with recurrent hematochezia, prompting an initial work-up for common causes; anal fissures, hemorrhoids, juvenile polyps, colitis, and proctitis were ruled out in the comprehensive initial assessment. A thorough physical examination revealed an incidental hemangioma on the buttock, broadening the differential diagnosis. Subsequent, diagnostic laparotomy identified a recto-sigmoid hemangioma, leading to low anterior resection.

We demonstrate the importance of performing a complete physical examination and broadening the differential diagnosis when common explanations have been excluded. We highlight an instance of rectal hemangioma leading to repeated occurrences of significant hematochezia and persistent anemia. A cutaneous hemangioma on the patient's buttocks broadened the potential diagnosis to include a GI hemangioma. While juvenile polyps represent the most common cause of lower GI bleeding in pediatric cases, it is crucial to consider GI hemangiomas, especially when previous endoscopic and imaging assessments have failed to reveal the cause of bleeding.

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Keywords: hemangioma, gastrointestinal bleeding, diagnostic laparotomy, histopathology, capsule endoscopy

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