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Student Expenses in Residency Interviewing

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ABSTRACT

Introduction. The student costs of residency interviewing are of increasing concern but limited current information is available. Updated, more detailed information would assist students and residency programs in decisions about residency selection. The study objective was to measure the expenses and time spent in residency interviewing by the 2016 graduating class of the University of Kansas School of Medicine and assess the impact of gender, regional campus location, and primary care application.

Methods. All 195 students who participated in the 2016 National Residency Matching Program (NRMP) received a 33 item questionnaire addressing interviewing activity, expenses incurred, time invested and related factors. Main measures were self-reported estimates of expenses and time spent interviewing. Descriptive analyses were applied to participant characteristics and responses. Multivariate analysis of variance (MANOVA) and chi-square tests compared students by gender, campus (main/regional), and primary care/other specialties. Analyses of variance (ANOVA) on the dependent variables provided follow-up tests on significant MANOVA results.

Results. A total of 163 students (84%) completed the survey. The average student reported 38 (1 - 124) applications, 16 (1 - 54) invitations, 11 (1 - 28) completed interviews, and spent $3,500 ($20 - $12,000) and 26 (1 - 90) days interviewing. No significant differences were found by gender. After MANOVA and ANOVA analyses, non-primary care applicants reported significantly more applications, interviews, and expenditures, but less program financial support. Regional campus students reported significantly fewer invitations, interviews, and days interviewing, but equivalent costs when controlled for primary care application. Cost was a limiting factor in accepting interviews for 63% and time for 53% of study respondents.

Conclusions. Students reported investing significant time and money in interviewing. After controlling for other variables, primary care was associated with significantly lowered expenses. Regional campus location was associated with fewer interviews and less time interviewing. Gender had no significant impact on any aspect studied. ***KS J Med 2017;10(3):50-54.***

INTRODUCTION

The National Resident Matching Program (NRMP) increasingly is challenging for participants and disruptive of the senior year of medical education.[1-4] In 2016, 18,187 students of U.S. allopathic medical schools were among 35,476 active applicants for 27,860 Post Graduate Year (PGY) 1 positions.[5] In 2015, the average successful U.S. allopathic student reported applying to 30 programs, receiving 16 interview invitations, and completing 12 interviews (Figure 1).[6] The U.S. seniors who did not match submitted an average of 54 applications, received six invitations, and completed six interviews. Individual students submitted an average of 1 - 67 applications depending on specialty.

Interviewing costs for U.S. students have not been reported extensively. Surveys have included graduates of one state,[7] selected institutions,[2] a regional campus,[8] and applicants to specific specialties.[9-14] The two largest studies had response rates of 20% and 47% respectively.[2,7] Low response rates potentially increase the selection bias of surveying specific groups. Total student costs ranged from under $100 to over $20,000 depending on the types of student and scope of costs studied. Several studies have reported lower costs for primary care applicants but other variables influencing cost and time have not been identified.[2,8]

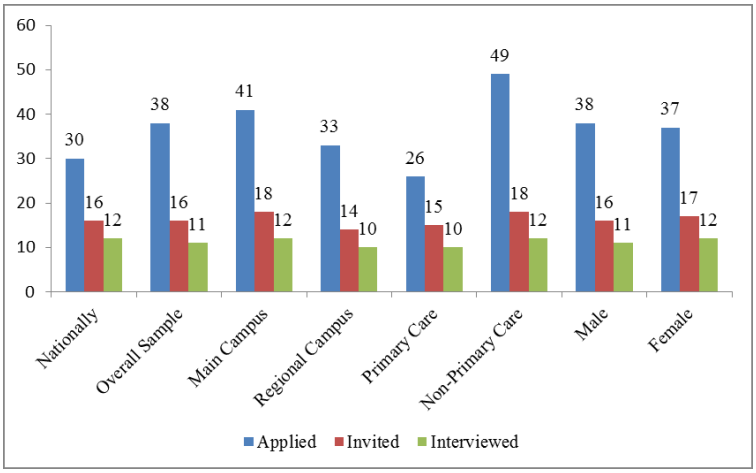

Figure 1. Average number of applications, invitations, and completed interviews by gender, campus type, and primary care application. Note: National data are 2015 NRMP report; study data are 2016.

This study examined the financial and time costs for residency interviewing of a large class of students and the influence of cost and time in interviewing decisions. The primary objective was to generate information to assist in advising students, inform residency programs, and contribute to curricular planning for the final year. We also were interested in identifying any differences between male and female students' experiences and any influence of regional campus location.

The primary care mission of the regional campuses was expected to lower costs, but this could be countered by the increased distances from major cities and generally higher air fares from regional sites.

METHODS

All fourth-year students of the University of Kansas School of Medicine (KUSM) who participated in NRMP during 2016 were surveyed immediately following announcement of NRMP results. The survey questionnaire was distributed by e-mail weekly for four weeks. Class leaders sent social media reminders two to three times weekly encouraging students to complete the questionnaire. As an incentive, a donation proportional to the response rate was offered to each campus graduation celebration fund.

The 33-item questionnaire was based on a 2015 study conducted on the KUSM Wichita campus,[8] literature reviews,[1-3,5-12] and input from faculty, residents, and students. The questionnaire addressed the number, specialty, and location of programs, variables influencing interview choices, cost and time of interviewing, sources of funding of interviews, and any costs covered by programs. The questionnaire included opportunities for narrative comments on specific items and the overall interviewing process. The instrument was pilot-tested by eight students who participated in early match processes. Minor changes were made to four questions to clarify meaning and avoid potential ambiguity.

Descriptive analyses provided details about the students and their survey responses. Chi-square tests were used to determine if there were any statistical differences by specialty choice (primary care versus non- primary care), gender (male and female), as well as campus location (main and regional). This test was chosen because it is used to compare observed frequencies to expected frequencies. T-tests were used to compare the average costs of interviewing by specialty choice (primary care versus non-primary care) and campus location (main and regional). This test was selected for these variables because they only have two levels, and the differences between the two levels were of interest. Multivariate analysis of variance (MANOVA) tests were used for simultaneous comparisons between students by gender, campus, and application to primary care (defined as all family medicine, internal medicine, pediatrics, and medicine/pediatrics programs). Analyses of variance (ANOVA) on the dependent variables were conducted as follow-up tests to all significant MANOVA results. Using the Bonferroni Method, each ANOVA was tested at the .025 level. MANOVAs were used because they are able to control for any correlations between dependent variables, while testing for significance between multiple groups. This study was approved by the University of Kansas Institutional Review Board.

RESULTS

Participants. Of 195 eligible students, 163 (84%) completed the questionnaire. The response rates were 78% (94/120) from the Kansas City campus, 91% (61/67) from the Wichita regional campus, and 100% (8/8) from the Salina regional campus. The mean respondent age was 28 (range 24 - 55) years and 130 (80%) were white (Table 1). Of the 32 non-responders, 26 were male (81%), and 26 were from the main campus (81%).

Seventy-six students (47%) applied to primary care programs. The percentage of primary care applicants was higher for women (52%) than men (42%) but not statistically significant ($\chi^2(1, N = 163) = 0.18$, $p = .21$). Similarly, the percentage of regional campus students applying to primary care (55%) was not significantly higher than the main campus (43%; $\chi^2(1, N = 163) = 0.11$, $p = .15$).

Volume of interviewing. Students applied to an average of 38 programs (range 1 - 124), received 16 interview invitations (range 1 - 54), and completed eleven interviews (range 1 - 28; Figure 1). One hundred and fifty-eight students (98%) interviewed out-of-state, covering 42 states, including Alaska.

A MANOVA to determine the effect of gender, campus (main or regional), and primary care on the five dependent variables related to the volume of interviewing (i.e., the numbers of applications, interview invitations and completions; and cost and time as limiting factors in interview decisions) found no significant difference for gender (Wilks's $\Lambda = .98$, $F(5,147) = .73$, $p = .60$, $\eta^2 = .02$), but significant differences between regional and main campuses (Wilks's $\Lambda = .89$, $F(5,147) = 3.75$, $p = .003$, $\eta^2 = .11$) and between primary care and non-primary care applicants (Wilks's $\Lambda = .75$, $F(5,147) = 9.8$, $p < .001$, $\eta^2 = .25$; Table 2).

Table 1. Study participants.

	Respondents (%) (N = 163)	
Sex		
Female	79 (49)	
Male	84 (52)	
Race		
White	130 (80)	
Asian	19 (12)	
Black	6 (4)	
Other or missing	8 (5)	
Campus		
Main	94 (58)	
Regional	69 (42)	
Speciality of Application		
Primary Care	76 (47)	31 (19%) family medicine 28 (17%) internal medicine 13 (8%) pediatrics 4 (2.5%) medicine-pediatrics
Non-Primary Care	87 (53)	35 (22%) surgical specialties 10 (6%) anesthesiology 9 (6%) obstetrics/gynecology 7 (4%) radiology, emergency medicine 6 (4%) psychiatry 3 (2%) dermatology, neurology, pathology 1 (0.6%) preventive medicine, pediatric neurology, other

Table 2. Significant ANOVAs by MANOVA variable.

MANOVA	Significant ANOVA			
	Campus		Primary Care Application	
	Main (N = 94)	Regional (N = 69)	Yes (N = 78)	No (N = 85)
Application Activity				
Applications			26 ± 15.07 (n = 76)	48.8 ± 23.83 (n = 83)
Interview offers	18.35 ± 9.8 (n = 93)	13.62 ± 8.36 (n = 66)		
Completed interviews	12.17 ± 4.59 (n = 93)	9.58 ± 4.0 (n = 66)	9.89 ± 4.06 (n = 76)	12.19 ± 4.68 (n = 83)
Financial Costs ($)				
Total spent interviewing			2825 ± 2422 (n = 69)	4254.51 ± 2446.59 (n = 72)
Number of funding sources			1.6 ± .66 (n = 69)	1.9 ± .72 (n = 72)
Any travel paid			1.26 ± .44 (n = 69)	1.1 ± .31 (n = 72)
Any lodging paid			1.95 ± .21 (n = 69)	1.7 ± .46 (n = 72)
Interview Time and Scheduling				
Days interviewing	28.17 ± 16.23 (n = 69)	19.21 ± 8.25 (n = 48)		
Interview offer response <10 mins.	1.6 ± 0.49 (n = 69)	1.81 ± 0.39 (n = 48)		

The ANOVA by campus type found no significant difference on total number of applications submitted ($F(1,151) = 2.78$, $p = .09$, $\eta^2 = .02$), cost as a limiting factor ($F(1,151) = .86$, $p = .35$, $\eta^2 = .01$), or time as a limiting factor in deciding to interview ($F(1,151) = 1.9$, $p = .17$, $\eta^2 = .01$). Students from the main campus were invited to significantly more interviews ($F(1,151) = 10.6$, $p = .001$, $\eta^2 = .06$), and completed more interviews ($F(1,151) = 12.9$, $p < .001$, $\eta^2 = .08$). The ANOVA found no significant difference for primary care application in cost as a limiting factor ($F(1,151) = .52$, $p = .47$, $\eta^2 = .003$) or time as a limiting factor in deciding to interview ($F(1,151) = .06$, $p = .80$, $\eta^2 < .001$). Non-primary care applicants applied to significantly more programs ($F(1,151) = 47.7$, $p < .001$, $\eta^2 = .24$), and completed more interviews ($F(1,151) = 9.2$, $p = .003$, $\eta^2 = .06$), but were not offered more interviews than primary-care applicants ($F(1,151) = 3.5$, $p = .06$, $\eta^2 = .02$; Table 2).

Financial costs of interviewing. The average reported cost for interviewing was $3,500 (range $20 - $12,000; Tables 3 and 4). On all campuses, applicants to primary care reported an average of about $1,400 less than their classmates applying to other specialties (Table 3). Twenty-two percent of all students spent less than $1,000. However, 35% of primary care applicants reported costs less than $1,000, compared to only 11% of those applying to other specialties ($p < .001$; Table 4).

Table 3. Estimated average total interviewing expenses ($) by campus and primary care application.

	Main Campus	Regional Campuses	All Students	p value
Estimated average costs (range)	3,652 (20 - 11,000)	3,342 (75 - 12,000)	3,516 (20 - 12,000)	0.461
Primary care applicants (range)	2,827 (20 - 7,000)	2,701 (75 - 12,000)	2,765 (20 - 12,000)	0.822
Non-primary care applicants (range)	4,305 (100 - 11,000)	4,087 (300 - 10,000)	4,219 (100 - 11,000)	0.713

Table 4. Estimated total interviewing expenses.

Amount Spent	Primary Care	Non-Primary Care	p value
$≤1,000	26 (35%)	9 (11%)	<.001
$1,001 - 5,000	39 (53%)	51 (65%)	<.001
$5,001 - 10,000	7 (10%)	18 (23%)	<.001
>$10,000	2 (3%)	1 (1%)	0.06

A MANOVA conducted to determine the effect of gender, campus location, and primary application on the five dependent variables related to financial cost of interviewing (i.e., total estimated expenses, the number of funding sources used, and any contribution from residency programs to travel, lodging, and meal expenses) found no significant difference for gender (Wilks's $\Lambda = .98$, $F(5,129) = .57$, $p = .72$, $\eta^2 = .02$) or campus (Wilks's $\Lambda = .98$, $F(5,129) = .48$, $p = .82$, $\eta^2 = .02$), but a significant difference between primary care and non-primary care application (Wilks's $\Lambda = .79$, $F(5,129) = 6.83$, $p < .001$, $\eta^2 = .21$; Table 2).

An ANOVA on the dependent variables found a significant difference in total estimated expenses between primary care and non-primary care applicants ($F(1,133) = 11.9$, $p = .001$, $\eta^2 = .08$). Students reported using the same funding sources (principally student loans, credit cards, gifts from family members), but non-primary care applicants reported using significantly more funding sources ($F(1,133) = 3.9$, $p = .05$, $\eta^2 = .03$). Students reported a wide range of program financial contributions. Ninety-two percent reported any assistance with payment for meals and 84% reported any contribution to lodging. Only 18% reported any assistance with travel. Primary care applicants were significantly more likely to report any contributions to travel expenses ($F(1,133) = 4.1$, $p = .05$, $\eta^2 = .03$) and lodging ($F(1,133) = 14.8$, $p < .001$, $\eta^2 = .1$), but no significant difference was demonstrated for meals ($F(1,133) = 1.8$, $p = .16$, $\eta^2 = .01$). For each category, the expenses covered by individual programs ranged from zero to all expenses (Table 2).

Interview time and scheduling. Students reported an average of 26 days spent interviewing (range 1 - 90).

November was the most common month with an average 4.2 interviews per student. Students reported an average 13 days' notice for interviews (range 1 - 60 days). All students perceived pressure to respond quickly to interview invitations: 36% responded within ten minutes and 72% within the hour. Only 5% waited more than 24 hours.

A MANOVA to determine the effect of gender, campus location, and primary care application on five dependent variables related to interview time and scheduling (i.e., days interviewing, number of cancelled and rescheduled interviews, prior notice, and responding to interview invitations within ten minutes) found no significant difference for gender (Wilks's $\Lambda = .91$, $F(5,105) = 2.03$, $p = .08$, $\eta^2 = .09$) or for primary care (Wilks's $\Lambda = .91$, $F(5,105) = 2.2$, $p = .06$, $\eta^2 = .09$). A significant difference was found between regional and main campuses (Wilks's $\Lambda = .87$, $F(5,105) = 29$, $p = .01$, $\eta^2 = .13$; Table 2).

The ANOVA found significantly more days devoted to interviewing for the main campus ($F(1,109) = 12.7$, $p = .001$, $\eta^2 = .10$) and a significantly higher proportion of students responding within ten minutes of interview invitation ($F(1,109) = 4.63$, $p = .03$, $\eta^2 = .04$). No significant campus differences were found for the number of cancelled interviews ($F(1,109) = 1.09$, $p = .29$, $\eta^2 = .01$), rescheduled interviews, ($F(1,109) = .55$, $p = .46$, $\eta^2 = .01$), or length of notice for each interview ($F(1,109) = 1.14$, $p = .29$, $\eta^2 = .01$).

DISCUSSION

This study provided a detailed picture of the residency interviewing experience of a large class of students at a tri-campus, Midwestern state medical school. The high response rate reflects student leadership and interest in the topic. The key findings are confirmation of the major impact of primary care specialty choice, the modest differences for regional campus students, and the absence of significant gender differences. Average expenses for non-primary care applicants were over 60% higher than those of primary care applicants. When adjusted for specialty choice, regional campus students did not report higher costs despite the distance of regional campuses from major cities. The absence of gender differences may reflect the similarity in specialty choice by KUSM male and female students (e.g., 17% of women and 19% of men applied to surgical specialties).

Similar to other studies,[2,7-14] our students spent an average $3,500 but the range was $20 to $12,000 and 22% of all students (and 35% of primary care applicants) spent less than $1,000. Students added expenses to existing debt, often using multiple funding sources. The topic of program financial support merits further study as programs compete for the best applicants; for example, nationally in 2016, Internal Medicine program directors reported receiving an average of 2,619 applicants and interviewing 201 applicants.[15]

The time spent interviewing has been reported in one previous study.[11] This study estimated a median of 20 days for applicants to urology programs in 2006. Time was a limiting factor in interviewing for 58% of students. A few students reported extremely high values, up to 90 days. Students may have under-reported time due to regulations about absences from fourth year courses. Time lost from education is of major concern. In addition to absences, we cannot estimate the negative educational impact of students distracted from their studies by concerns about the match process. Student narrative comments described significant stress over obtaining and completing interviews, especially those involving frequent schedule changes. Students reported that receiving interview invitations in distant cities with only one to two days' notice was not uncommon, especially late in the interviewing period. Many students experienced constant vigilance and a sense of urgency in decisions about interviewing.

Primary care students received interview invitations from about 60% of applications. Those applying to non-primary care averaged invitations from 37% of applications despite applying to significantly more programs. Both groups of students failed to complete interviews for about one third of invitations. Further research is indicated into the reasons for declining or cancelling interviews, but 63% of our students reported limited interviewing because of financial concerns.

The study has several limitations, including being conducted in a single institution, self-reported costs, possible recall bias, and the definition of primary care that includes students intending to subspecialize. Similarly, grouping surgical specialties masks differences among different specialties. We were unable to include measures of student "competitiveness" in our analysis without compromising anonymity. Application of our findings to other schools must be individualized.

To the extent that our findings are generalizable to other institutions, they provide financial data to the debate over the escalating number of NRMP applications per student. This trend raises costs and strains resources for students and programs despite a sustained match rate for U.S. allopathic graduates of around 94%.[1,5,16-21] Our report also draws attention to the days lost from education in the fourth year of medical school at a time when national curricular innovations increasingly emphasize the crucial role of the final year in achieving competencies and transitioning to the residency stage of education.

Further studies are indicated in the role of cost and other factors in the failure to complete interviews after invitation, and into the extent and significance of program financial contributions to student interviewing expenses.

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Comparisons of Medical Student Knowledge Regarding Life-Threatening CT Images Before and After Clinical Experience

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ABSTRACT

Introduction. Currently, no national standard exists for educating medical students regarding radiography or formal research indicating the level of improvement regarding computed tomography (CT) interpretation of medical students during clinical rotations.

Methods. Students were evaluated based on their response to twenty-two open-ended questions regarding diagnosis and treatment of eleven de-identified CT images of life-threatening injuries. The number of incorrect answers was compared with correct or partially correct answers between students starting third-year clinical rotations and those starting their fourth year.

Results. Survey results were collected from 65 of 65 (100%) beginning third-year students and 9 of 60 (15%) beginning fourth-year students. Students in their fourth-year had less incorrect answers compared to third-year students, with five questions reflecting a statistically significant reduction in incorrect responses. The image with the least incorrect for both groups was epidural hemorrhage, 33.9% and 18.5% incorrect for third-year students for diagnosis and treatment, respectively, and 11.1% and 0% incorrect for fourth-year students. Outside of this image, the range of incorrect answers for third-year students was 75.4% to 100% and 44.4% to 100% for fourth-year students.

Conclusion. Baseline CT knowledge of medical students, regardless of clinical experience, indicated a strong deficit, as more students were incorrect than correct for the majority of CT images. ***KS J Med 2017;10(3):55-58.***

INTRODUCTION

Currently, there are no national standards for educating medical students regarding radiography interpretation in the trauma population. Radiology clinical rotations were required in only a quarter of U.S. medical schools as recently as 2009 to 2010.[1] Among U.S. medical students surveyed, over three-fourths planned to take a radiology elective before residency.[2] The majority of these students believed radiology changes patient care or was as important as a physical exam.[2] In addition, general surgery program directors reported the ability to read abdominal x-rays and computed tomography (CT) imaging, among other radiologic-related tasks, as essential capabilities for incoming residents.[3,4]

Introduction to radiology in the clinical or hospital setting, even in the early phases of a student's medical education, can influence their perception of imaging interpretation.[3,5,6] However, institutions vary with regard to incorporation of radiology training. One approach that has shown success is the integration of medical imaging with an anatomy course.[6-10] A study at Boston University School of Medicine evaluated the impact of CT scans of cadavers on students' anatomy education and spatial relationships, with positive results.[6] Two similar studies also found that inclusion of CT images in cadaver labs yields positive student perspectives and significant improvement in radiology skills.[9,10]

Although the literature provides numerous examples of studies related to medical student interpretation of radiographs, no formal study specifically has indicated the level of improvement of CT knowledge after one year of clinical rotation for U.S. medical students.[11-14] Therefore, the purpose of this study was to observe and compare the baseline knowledge regarding CT interpretation of traumatic injuries for medical students starting clinical rotations to those completing their required rotations. Evaluating the extent of radiographic knowledge gained from clinical rotations alone in a setting lacking an emphasis on radiology education would provide the impacting factor. From this analysis, improvements and future discussion can be made regarding basic radiologic knowledge for medical students.

METHODS

All volunteer medical students tested were from the University of Kansas School of Medicine-Wichita (KUSM-W). The medical student curriculum at KUSM-W incorporates two years of didactic learning, followed by two years of clinical rotations. Radiology-specific education is not integrated into the core curriculum. However, during the surgical clinical rotation students partake in overnight trauma. Surgery residents are to involve medical students as appropriate; introduction to and education of CT imaging are expected.

Two separate groups were utilized for comparison: medical students beginning their third-year of clinical rotations (MS3), and medical students who recently had completed their third-year and were beginning their fourth-year of clinical rotations (MS4). Following informed consent, both groups participated in a timed, open-ended survey to evaluate their ability to interpret CT images typical of high-risk trauma situations.

De-identified single images of 11 different CT scans representing potential life-threatening injuries were identified by a board-certified trauma surgeon (Table 1). There were two questions per CT, for a total of 22 questions. Students were asked to identify: 1) the correct diagnosis, and 2) the correct treatment for the correct diagnosis. The students were instructed that each CT scan represented a life-threatening injury, as determined by two trauma surgeons, each having completed a fellowship in trauma and critical care surgery. Both groups were exposed to the same images in a controlled setting and were given a maximum of two minutes to view each image and record their interpretation of the image regarding diagnosis and treatment.

Table 1. Life-threatening computed tomography injury and treatment images.

Injury Type	Treatment
Head	
Epidural hematoma (EDH)	Operative intervention or drainage
Subdural hematoma (SDH)	Medical management
Intraparenchymal hemorrhage (IPH)	Medical management
Chest, Abdomen and Pelvis	
Pulmonary contusion and pneumothorax	Chest tube
Grade III liver laceration	Observation in the intensive care unit
Grade III liver laceration	Observation in the intensive care unit
Grade IV splenic injury	Embolization or operative intervention
Grade IV renal injury	Embolization or operative intervention
Pelvic fracture	Operative intervention or sacroiliac screw
Small bowel thickening	Serial exam or operative intervention
Right colon mesenteric injury	Serial exam or operative intervention

Survey forms were de-identified when scored and were reviewed separately and scored by two trauma surgeons. One point was assigned for a correct response, half a point for a partially correct response, or zero points for an incorrect response. Each student's scores were averaged for each of the 22 questions. Both groups were compared by total points for each image, and proportion of incorrect responses was calculated by group. Differences in proportions were calculated.

Due to sample size, focus on the error reduction comparison was viewed through proportional differences, assessing statistical significance with a 95% confidence interval, corrected for continuity. Confidence intervals of 95% were calculated, of which those intervals, including zero, were considered statistically insignificant. Bonferroni correction indicated one out of 18 comparisons, given this confidence interval. Analyses were conducted using SPSS release 19.0 (IBM Corp, Somers, New York). The study was approved by the Institutional Review Board of Via Christi Hospitals, Wichita, Inc.

RESULTS

Survey results were collected from 65 of 65 (100%) MS3s and 9 of 60 (15%) MS4s (N=74). Overall, MS4s performed better than MS3s, with fewer incorrect responses on 20 of 22 questions (Figures 1 and 2). Two exceptions were noted: diagnosis of a grade IV renal injury (96.9% incorrect for MS3s and 100% incorrect for MS4s) and treatment of a grade III liver laceration (95.4% incorrect for MS3s and 100% incorrect for MS4s). Neither were statistically significant (95% CI: 7.2 to 1.1% and -9.7 to 0.49%, respectively).

Percentage of incorrect responses ranges from 18.5% to 100% for MS3s and from 0.0% to 100% for MS4s. The image with the least incorrect responses by both groups was epidural hemorrhage, 33.9% and 18.5% incorrect by MS3s for diagnosis and treatment, respectively, and 11.1% and 0% for MS4s. Excluding epidural hemorrhage, the range of incorrect for MS3s was 75.4% to 100% and 44.4% to 100% for MS4s. The median percentage of incorrect responses for MS3s was 93.1% and 77.8% for MS4s. No MS3s were able to identify or propose a correct diagnoses or treatment for one of two grade III liver lacerations. No MS4s correctly diagnosed the grade IV renal injury and no MS4s correctly identified a treatment for one of two grade III liver lacerations.

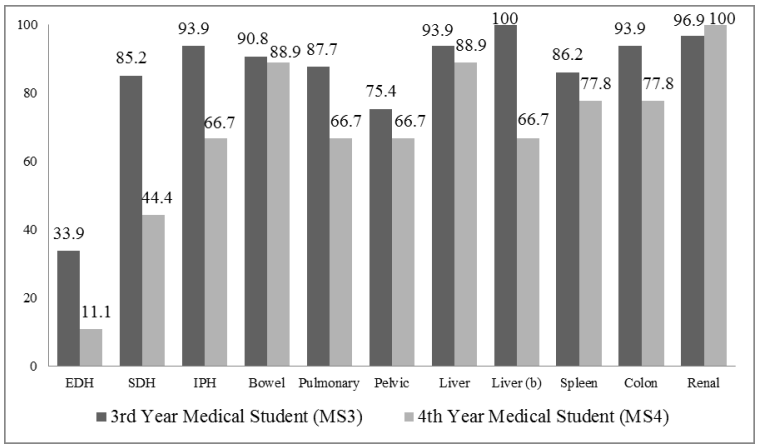

Figure 1. Percentage of incorrect responses for diagnosis by group.

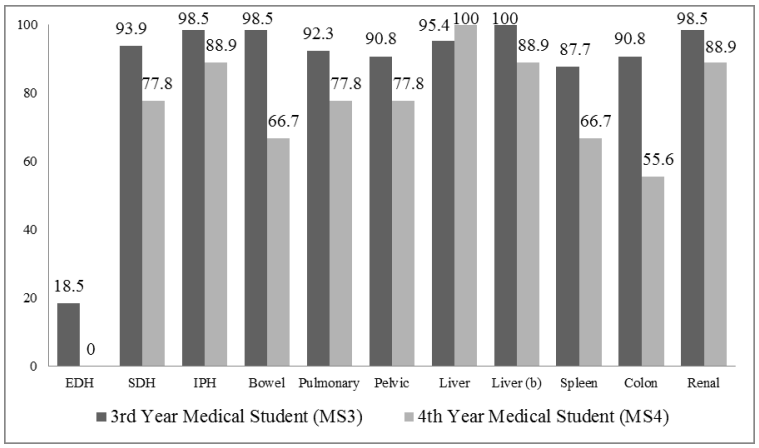

Figure 2. Percentage of incorrect responses by treatment by group.

Five of the twenty-two questions reflected a statistically significant reduction in incorrect responses between MS3s and MS4s. These included: diagnosis of subdural hemorrhage (85.2% incorrect MS3 versus 44.4% MS4, 95% CI: 8.2% to 75%); diagnosis of grade III liver laceration (100% MS3 versus 66.7% MS4, 95% CI: 2.5% to 64%); treatment of epidural hematoma (18.5% incorrect by MS3 versus all correct by MS4, 95% CI: 9.0% to 28%); treatment of small bowel thickening (98.5% MS3 versus 66.7% MS4, 95% CI: 0.85% to 63%); and treatment of right colon mesenteric injury (90.8% MS3 versus 55.6% MS4, 95% CI: 2.0% to 68%).

DISCUSSION

By comparing pre- and post-evaluations, several studies have demonstrated that medical students CT interpretation abilities improve with radiology-focused training.[15-17] Sendra-Portero et al.[15] and Scheiner et al.[16] compared medical students of different years of study and assessed their abilities in interpreting radiology images before and after a radiology-specific training. Results indicated that medical students improved in interpreting radiographs after the training, regardless of year of study.[15,16] Dawes et al.[17] also found medical students to improve in interpreting radiographs after participating in a 26-week clinical training course. Results showed the proportion of correct answers improved from 8% pre-evaluation to 43% post-evaluation ($p<0.001$). Our study had similar results; however, the improvement was only slightly better for fourth-year students.

Of the twenty-two possible answers, MS4s did better than MS3s in all but two, indicating some improvement in reading CT imaging. However, both groups had a high range of incorrect responses. A median value of 93.1% incorrect by MS3s indicated the baseline CT knowledge of medical students entering clinical rotations was extremely low. As such, it is not surprising that MS4s had a mild improvement. Other than diagnosis and treatment of epidural hemorrhage, MS3s scored greater than 75% incorrect on all other questions. Although the median value for MS4s at 77.8% incorrect was lower than MS3s, it indicated a majority of students incorrectly identifying and ultimately treating injuries seen on CT scans.

Both groups performed best in diagnosing and treating an epidural hematoma. As MS3s did best with this injury, it raises the question if prior didactic learning regarding head injuries may have better prepared the students. However, MS3s did not perform particularly better on the other head injuries when compared to MS4s. No particular trend was noted regarding percentage incorrect and body regions.

Most surgeons expect MS3s to have a baseline ability to read CT scans and MS4s are expected to be able to identify life-threating images. Yet, this study showed a strong deficit in baseline CT knowledge amongst medical students. Despite the low number of MS4s, after a year of clinical rotations and overnight trauma calls, which included education on CT imaging, they did show some improvement in evaluating CT images. However, without a standard curriculum in radiology, it is difficult to conclude if this improvement is significant enough to warrant satisfactory expectations of a beginning fourth-year student. Still, for medical education purposes, clinical rotations appear to provide a benefit to students in education of CT imaging of life-threatening injuries.

Areas for potential study include improving or expanding upon the findings of the current study. Within the study, the benefits of viewing an entire CT scan may provide a more thorough investigation of student abilities. In addition, after completion of this study, a new radiology rotation was implemented. This new program may impact the current study results, therefore, a possible follow-up study may be beneficial.

Similar studies at other institutions may provide groundwork for average radiographic education, but without national standards or expectations, it would be difficult to conclude if an intervention is necessary. Future studies confirming these results might include comparison of students who had received imaging-specific education, building upon studies such as at Boston University School of Medicine.[6] At the campus in this study, students are allowed to undergo a radiology elective in the fourth year. Comparisons between students who choose this elective with those who choose alternative electives may provide more solid results upon the benefits of imaging-specific education.

The most appropriate intervention from this study would be continued comparisons after clinical rotations with the addition of imaging-specific education. For our studies, pursuing a continued study of current MS3s at the end of their third-year would provide stronger conclusions on the effect of radiographic-specific education, as baseline CT knowledge already has been attained. Through this, more studies can be developed to achieve a thorough understanding of medical students' radiographic knowledge, as well as how to improve their education and help them achieve optimal competency for residency and as physicians.

This study had several limitations. As this was a voluntary study with no compensation provided to participants, there were no expectations for subject participation numbers, although similar numbers were anticipated from both groups. However, due to the small number of fourth-year medical students, this group is not represented adequately. Further, the study tested students with one image slice of a CT scan as opposed to a complete CT scan set, a scenario unlikely in real life. Comparative slices on a CT scan may help the reader better analyze the severity and extent of the injury. Also, the patient's clinical history could have assisted students in their evaluations. Finally, the findings may not be generalizable to other trauma centers since this study was conducted at a single center.

CONCLUSIONS

The high percentage of incorrect responses reflects a strong deficit in baseline CT knowledge amongst medical students, particularly in an environment with limited radiologic education. Outside of diagnosis and treatment of head injuries, most students from both groups answered diagnosis and treatment incorrectly for the majority of the scans. If more than half of students are expected to identify these images correctly, other interventions are necessary to ensure better radiographic education. This study argues that a re-evaluation of current standards for radiographic education of medical students is needed. In addition, the possibilities of how to implement this education should be considered, whether it is through utilization of radiologist involvement and/or curriculum-specific education.

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Keywords: x-ray computed tomography, medical students, knowledge, clinical clerkships

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Safe Sleep Knowledge and Use of Provided Cribs in a Crib Delivery Program

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ABSTRACT

Introduction. Risk of infant sleep-related death can be reduced through safe sleep practices. Barriers to infant safe sleep have been mitigated through education and crib distribution, however, previous studies have not explored whether distributed cribs are put to use.

Methods. In a rural Michigan county, the Great Start Sleep Initiative supplied cribs and education shortly after infant birth to families with high-risk of infant mortality, as assessed through comprehensive interviews with families by program staff. Participant knowledge was evaluated using structured pre- and post-assessments before and after education. Further, a home visit was conducted to evaluate the infant's sleeping environment. Data from the program, collected between January 2012 and December 2014, were evaluated.

Results. Cribs and concomitant education were delivered to 75 caregivers. Knowledge of safe sleep practices increased significantly at follow-up with 67 caregivers (89%) affirming back positioning, 68 (91%) endorsing removal of unsafe items or soft objects, such as blankets, from the sleeping area, and 42 (56%) renouncing bed-sharing. At the home visit, 74 caregivers (99%) were using a crib to put their infant down to sleep, 70 (93%) were using the provided crib, and 67 (89%) had no unsafe items in the child's sleeping area.

Conclusion. Providing education to high-risk mothers resulted in improved safe sleep knowledge and provided cribs are used in these homes. ***KS J Med 2017;10(3):59-61.***

INTRODUCTION

Infant mortality is a critical measure of population health. Despite declines following the 1994 launch of the Back-to-Sleep campaign, sudden infant death syndrome (SIDS) remains a leading cause of infant death.[1,2] Although the number of SIDS diagnoses decreased overall secondary to supine sleep position recommendations, other types of sleep-related infant deaths, including accidental suffocation and strangulation, increased.[3] This led the American Academy of Pediatrics to revise its guidelines to emphasize sleep environment as well as positioning.[4,5]

In August of 1998, the Cribs for Kids campaign was launched in Allegheny County, Pennsylvania.[6] This program distributed full-sized cribs and mattresses, along with written educational materials, to low-income families. Following this initiative, the local SIDs rate dropped by 63%. Parents reported that without the Cribs for Kids program, babies would have slept in an adult bed, on the floor, or other unsafe location. The Cribs for Kids program became a model for resource provision and behavior change among low-income individuals and similar programs have been adopted in many states.

In Michigan, about 120 infants die suddenly and unexpectedly in unsafe sleep environments each year.[7] In Van Buren County, the need for further safe sleep education and resources was identified through home visiting programs and child death reviews. The Great Start Safe Sleep Initiative was created to provide one-on-one training on safe sleep practices for families with demonstrated need and a safe sleep set containing a portable crib, an infant wearable blanket, two fitted sheets, and literature on safe sleep. Need was determined holistically by maternal infant health program (MIHP) staff, with indicators including low-income, racial minorities, and migrant worker status. The staff ultimately make the determination of need after meeting and interviewing the family. The majority of sleep sets were delivered by MIHP staff who were involved with these families. The MIHP also conducted follow-up visits, giving staff an opportunity to evaluate the impact of safe sleep training.

Prior to delivery of the safe sleep set, a survey was conducted with a caregiver from each family to determine knowledge about safe sleep. Approximately two months after the sleep set was delivered, the safe sleep trainer contacted the caregiver by telephone to discuss any concerns and administer a survey to check knowledge retention. The trainer reminded the caregiver of items they have forgotten and scheduled a follow-up home visit. At the visit, the trainer completed a checklist by interviewing caregivers and viewing the portable crib to ensure that only one child was using the crib, that the crib was assembled properly, no hazards were nearby, and that no soft objects were in the crib. The results were reviewed with the parent and any concerns are addressed.

The purpose of this study was to analyze home visit reports and changes in knowledge from this program.

METHODS

The Great Start Sleep Initiative provided de-identified data for all mothers with a follow-up home visit between January 2012 and December 2014. These data were collected originally for program purposes and contained caregiver responses to the two knowledge questionnaires and the checklist completed by the MIHP staff. This study was determined to be exempt from review by the University of Kansas School of Medicine-Wichita Human Subjects Committee.

Caregivers were asked on both surveys what they knew about safe sleep; open-ended responses were summarized post-hoc across four themes (back positioning, crib/bassinet location, no bed sharing, and no items in the crib) and coded as safe/unsafe. Knowledge was compared between both caregiver questionnaires using McNemar's tests. The home visitor's checklist was summarized to determine how many parents had a crib assembled and in use at the time of visit; written comments by MIHP staff were reviewed. Analysis was conducted in June 2015.

RESULTS

In total, 75 families were included in this evaluation. Infants were predominantly Hispanic (61%) with an average age of seven weeks (SD = 12) at referral. On average, cribs were delivered when the child was nine weeks old (SD = 12), and home visits were completed at 22 weeks (SD = 12). Put another way, cribs were delivered two weeks (SD = 4) after referral and home visits were conducted 13 weeks (SD = 6) after crib delivery.

Reported household size ranged from two to 11 individuals with a median of five. On the pre-test, 62 respondents (85%) indicated they had received safe sleep education previously. Only four respondents indicated a friend or family member had given them information about safe sleep. Other major sources of safe sleep information were community services (n = 40, 53%) and health care providers (n = 36, 48%), including doctors, nurses, and hospital workers.

Respondents' knowledge was measured across the four identified themes. At baseline, 44 respondents (59%) were aware of back positioning, 40 (53%) noted that a crib was part of a safe sleep environment, 53 (71%) mentioned eliminating unsafe items from the sleep environment, and 23 (31%) explicitly addressed not bed sharing (Table 1). At follow-up, knowledge of back positioning, removing items from sleeping area, and avoiding bed sharing improved. While a higher proportion of respondents noted the importance of a crib as a safe sleep environment, the difference was not statistically significant.

Regarding intentions at time of referral, 30 respondents (48%) indicated that they would place their infant in a crib, portable crib, or bassinet to sleep, 36 (59%) reported they would put nothing other than a fitted sheet in the place where their baby sleeps, 66 (92%) reported not allowing smoking indoors, and 56 (85%) affirmed that if they smoked they change their clothes before holding their baby (Table 1). Reports of safe location and eliminating hazards in the sleeping area were improved following crib delivery. Smoking reports were not significantly different on follow-up.

At the home visit, 68 households (91%) had the provided crib present and assembled. An additional two households (3%) had the crib travel with the child to daycare, explaining its absence at the time of the visit. Among households without the provided crib, two received a separate full-sized crib that they were using while keeping the portable crib at another caregiver's house, one had damaged the crib irreparably and disposed of it, and one said their infant disliked sleeping in the crib. In total, 73 households (97%) had a crib set up for their infant to sleep in. Three households (4%) had clothes or blankets draped over the edge of the crib, but no other unsafe sleep elements were observed in cribs by the home visitor.

Table 1. Comparison of pre- and post- surveys collected between January 2012 and December 2014.

	Pre n = 75*	**Post** n = 75**	**p value**
Knowledge, n (%)			
Back positioning	44 (59)	67 (89)	<0.001
In a crib or bassinet	40 (53)	33 (65)	0.078
No items in sleep area	53 (71)	68 (91)	0.003
No bed sharing	23 (31)	42 (56)	0.003
Intentions/Behaviors, n (%)			
Safe location	30 (48)	74 (99)	<0.001
No items in sleep area	36 (59)	67 (89)	0.002
No smoking indoors	66 (92)	71 (95)	0.500
Avoid third hand smoke exposure	56 (85)	62 (84)	0.454

*n for *No smoking indoors* = 72, *Safe location* = 62, *No items in sleep area* = 61, *Avoid third hand smoke exposure* = 66.
**n for *In a crib or bassinet* = 51, *Avoid third hand smoke exposure* = 74

DISCUSSION

Previous studies have shown that caregivers can be knowledgeable about infant safe sleep but do not always follow recommendations.[8,9] To the authors' knowledge, this was the first study to show that, when provided cribs, most caregivers use them and maintain a safe sleep environment for their infant. Providing concomitant cribs and education to mothers resulted in improved safe sleep knowledge and use of the crib months after these resources were provided. Few mothers obtained other cribs, and only one infant was reported not to sleep in a crib.

One study limitation is that the families followed in this study are potentially non-generalizable, coming from one Midwestern county. Also, while mothers may not have otherwise found a way to obtain a crib, it was determined prior to crib delivery that families could not afford a crib and very few mothers obtained another crib from a friend or family member. Finally, while home visitors were able to assess the sleep environment, visits were in the middle of the day and no observations were made of infants asleep in the cribs. Despite these limitations, given that no previous studies have evaluated the at-home use of cribs from similar distribution programs, this evidence supported future growth and exploration of these programs. Studies should continue to evaluate whether these findings are replicable in other communities.

CONCLUSION

For at-risk families, the lack of resources, namely a crib, may be the primary reason for putting infants in unsafe sleep environments. In this sample, cribs distributed to families in need were employed, effectively reducing the risk of sleep-related death for these infants.

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Keywords: infant mortality, sudden infant death, infant equipment, health education

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Bone Health Improvement Protocol

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ABSTRACT

Introduction. Metabolic bone disease is a malady that causes significant morbidity and mortality to a patient who has sustained a fragility fracture. There is currently no protocol to prevent secondary fragility fracture at our institution. The objective of this study was to create an appropriate protocol for implementing clinical pathways for physicians to diagnose and treat osteoporosis and fragility fractures by educating patients.

Methods. A multidisciplinary team created an appropriate protocol that could be implemented in an inpatient setting. A thorough literature review was conducted to evaluate potential barriers and efficacious methods of protocol design.

Results. A bone health improvement protocol was developed. Any patient over the age of 50 who sustains a fracture from low energy trauma, such as a fall from standing or less, should be considered to place into this protocol. These patients received education on metabolic bone disease, a prescription for high dose vitamin D therapy, and laboratory testing to determine the etiology of their metabolic bone disease. Continuity of care of these patients with their primary care provider was provided for further management of their metabolic bone disease and evaluation of their disease after discharged from the hospital.

Conclusion. Comprehensive secondary prevention should consist of osteoporosis assessment and treatment together with a fall risk assessment. With this protocol, secondary fragility fractures potentially could be prevented. ***KS J Med 2017;10(3):62-66.***

INTRODUCTION

Osteoporosis is a prevalent metabolic bone disease among the elderly. It is defined as a disorder with micro-architectural deterioration that impairs both bone structural properties and bone quality.[1] This is a significant public health issue that predisposes 50% of patients over age 50 to an increased risk for fragility fracture.[1-5] Fragility fractures, defined as bone fractures resulting from a low-energy trauma such as a fall from a standing height or less, are a consequence of low bone quality and density.[6,7] These types of fractures are encountered most commonly in the hip, spine, distal radius, and proximal humerus. Hip fractures are the major cause of morbidity and mortality associated with osteoporosis and fragility fractures.[1] The risk of mortality for elders after a hip fracture due to low energy trauma is twice that of the general population. Osteoporosis and fragility fractures pose enormous challenges for both the individual and society in terms of loss of independence, quality of life, and economic burden.[8,9] These include long hospitalization, need for surgical treatment, increased disability, and partial or complete loss of the ability to perform activities of daily living independently.

El-Rabbany et al.[10] found only 5 to 38% of patients with fragility fractures were being treated for osteoporosis at final follow-up. Identifying patients at risk and getting the proper evaluation and treatment are not universal. A disconnect exists between the realization that fragility fractures are the stigmata of osteoporosis and the engagement of the patient and physician team toward more universal diagnosis and treatment.

Orthopedic residency and curricula may not provide sufficient knowledge or training to allow osteoporosis management.[11] Edwards et al.[12] demonstrated a modest increase in certain aspects of bone health order pathways and treatment by using an electronic medical record order set. That intervention created with providers' input increased the follow-up and treatment of patients with osteoporosis. This, however, failed to increase diagnosis or treatment for osteoporosis at the time of hospitalization for a fragility fracture.

No protocol exists to prevent secondary fragility fracture at our institution. The objective of this study was to create an appropriate protocol for implementing clinical pathways for physicians to diagnose and treat osteoporosis and fragility fractures by educating patients.

METHODS

A multidisciplinary team, which consisted of physicians, nurse practitioners, physical therapists, nurse managers, and the orthopedic service line coordinator, was assembled to create an appropriate protocol that could be implemented at a level 1 trauma center about metabolic bone disease and fragility fractures. This team was tasked with vetting the protocol to ensure feasibility in implementation at a clinical level as well as ease of modification after implementation. A thorough literature review was conducted to evaluate efficacious methods of protocol design and potential barriers to implementation. The literature reviews also encompassed treatment goals for patients with osteoporosis and fragility fracture.

RESULTS

A bone health protocol was developed by the multidisciplinary team (Figure 1). This protocol was created to improve care for patients at risk for fragility fracture or post-fracture which focused on initiating and facilitating the screen and treatment of osteoporosis. It divided into several strategic steps: scenario, lab tests, patient education, vitamin D prescription, and primary care provider follow-up.

Scenario. Orthopedic surgeons, trauma surgeons, and emergency room (ER) providers often are the first clinicians to see the patients after a fragility fracture. A patient over the age of 50 who sustains a fracture to the appendicular skeleton caused by a low energy trauma event, such as a fall from standing height or less, should be placed into this protocol. The incidence and lifetime risk of any fracture doubles every decade after 50 years old.[4,11,13-15] During the visit, a standard medical history also should be obtained, with particular attention paid to age, weight, personal and family history of fracture, physical inactivity, medication, alcohol, tobacco, and frailty.

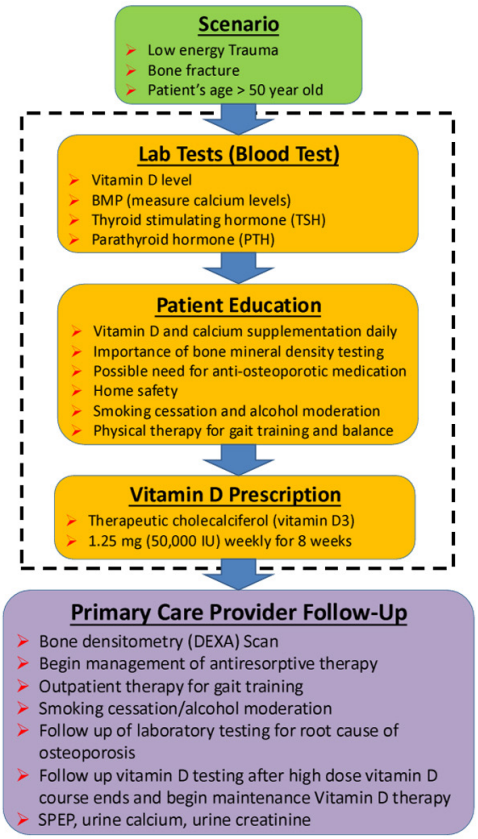

Figure 1. The bone health protocol with treatment goals to be provided before the patient leaves the hospital.

Laboratory Tests (Blood Test). Although bone strength cannot be determined directly in vivo, with increased age comes a marked reduction in bone mass and destruction of bone architecture, leading to a considerable decrease in bone strength.[16-18] Basic laboratory tests, such as a complete blood count, serum chemistry profile, and urinalysis, are usually requested by the clinicians during a regular medical checkup to monitor patient health. Adding a basic metabolic profile, parathyroid hormone level, thyroid stimulating hormone, follicle-stimulating hormone level, luteinizing hormone level, and Vitamin D-25-hydroxy level to these tests would help in determining the ethology for metabolic bone disease. The results of these tests give clinicians insight into patient's status regarding common etiologies of metabolic bone disease, including decreased vitamin D levels, hyperparathyroidism, hyperthyroidism, renal osteodystrophy, and hypogonadism. These tests are among the most effective in determining etiology of metabolic bone disease based on literature.[19]

Patient Education. Patients with osteoporosis who have sustained a fracture have a very high risk of suffering a new fracture, often within one year of original fracture.[14,20-28] Therefore, before discharging the patients from the hospital, nursing staff, and healthcare providers must provide proper education to patients and their family members about metabolic bone disease. This includes acute management of the presenting fracture and prevention of secondary fragility fractures, the importance of vitamin D and calcium supplementation, bone mineral density (BMD) testing, the possible need for anti-osteoporotic medications, home safety goals, smoking cessation and alcohol moderation, and physical therapy for gait training and balance. Patients who underwent balance training and education had better balance measures and fear of falling outcomes.[29-31] Smokers should be advised to quit, patients with alcoholism should be treated, and patients for whom risk factor analysis indicates a strong potential for osteoporosis should have an ultrasound of the heel as an initial screening tool every six months followed by a bone densitometry (DEXA) scan in those identified as having low bone density.[32] This education will allow patients and their family members to be involved in the patient's bone health.

Vitamin D Prescription. Vitamin D is essential for normal calcium metabolism and maintenance of bone density, and the risk of deficiency increases with age.[33-36] The prevalence of vitamin D deficiency in 2010 in the U.S. was 41.6% with deficiency rates around 49% in patients age 55 to 64 years.[37] Due to the high levels of vitamin D deficiency among elderly individuals and the delay in test results, which may take up to five days due to the specialized nature of the test and scarcity of laboratories that perform it, there is a benefit to start therapeutic cholecalciferol (vitamin D3) prophylactically before discharge from the hospital. Supplementation with vitamin D reduced bone loss and the incidence of non-vertebral fractures in men and women aged ≥65 years.[38] Patients should be prescribed vitamin D supplementation (vitamin D3) for eight weeks at a dose of 1.25 mg or 50,000 international units (IU) once a week which is supported by previous studies.[39-41] With this high dose of vitamin D supplementation (50,000 IU) cholecalciferol restored serum 25-hydroxy vitamin D (25(OH)D) levels to sufficient levels (i.e., above vitamin D deficiency level of 50 nmol/L)[42,43] among migrants and non-migrants, especially for those with lower baseline serum 25(OH)D.

Primary Care Provider Follow-up. The ultimate goal in treating fragility fracture patients with osteoporosis is not only acute management of the presenting fracture, but also the prevention of subsequent fractures.[7,44-47] The primary care providers are the crucial members that need to provide continuity of care with these patients on their metabolic bone disease management and further evaluation of their disease after the patient is discharged from the hospital. A DEXA scan should be scheduled to measure and evaluate BMD. The results of the DEXA scan can be used to gauge the severity of bone loss, predict future fracture risk, make treatment decisions, and monitor changes in BMD related to age, medical conditions, or therapeutic intervention. The provider should discuss initiation of antiresorptive therapy, outpatient physical therapy for gait training, smoking cessation, and alcohol intake moderation. By evaluating the initial routine laboratory test results, the primary care providers should make the decision on continuing therapeutic cholecalciferol (vitamin D3) treatment and, if necessary, order further testing, such as serum protein electrophoresis, 24-hour urine calcium, and 24-hour urine creatinine, to delineate the etiology of the metabolic bone disease.

DISCUSSION

The goal of this bone health improvement protocol was to ensure that patients with osteoporosis and fragility fractures receive quality care for their bone health in both the inpatient and outpatient settings. About 10 million Americans over the age of 50 have osteoporosis and that number will increase to 14 million by 2020.[15] These patients are high risk and should be monitored closely for osteoporosis in the setting of any fracture. There is a large gap between what has been learned and what is applied by patients and health care providers. The biggest problem is a lack of awareness of bone disease among both the public and health care professionals.[32]

Patients who have had a fragility fracture have hypovitaminosis D 73% of the time.[48] This is in line with current levels in the United States and Canada in a population without fracture. A prospective randomized trial in 2009 demonstrated a trend toward a decrease in fracture incidence in patients who took daily vitamin D and calcium supplementation.[49] High dose vitamin D3 (≥ 300,000 IU) is efficacious in treating low levels of vitamin D and restoring the level to a normal limit.[39] Kearns et al.[50], however, concluded that a high dose of vitamin D3 (≥ 600,000 IU) at one time will have adverse effects which could cause hypercalcemia or hypercalcinuria.

Osteoporosis is thought to be caused by factors including age-related impairment of bone formation, decreased calcium and vitamin D intake, decreased physical activity, and estrogen's positive effects on calcium balance in the intestines, kidneys, and bone.[51] Providing patients with the adequate information to take control of their osteoporosis is crucial to the success of this protocol. Patient education, such as the benefit of smoking cessation, should be emphasized, especially in the setting of fracture. Tobacco has been shown to hinder fracture healing and alcohol consumption of three or more units per day will have consequential effects on bone health, leading to lower BMD when compared with more moderate drinking.[6] Education on avoidance of preventable falls also has a major impact on reducing further fragility fractures as patients with osteoporosis often experience muscle weakness, postural deformity, and poor balance.[52] Patients who undergo tailored exercises and intervention have a decrease in fall rate in the community.[53] These measures should assist in decreasing the rate of recurrent fragility fracture.

Elderly patients presenting with fragility fractures should be offered assessment with this protocol by orthopedic and/or trauma surgeon teams, as they have a unique opportunity to diagnose, arrange follow-up, and ensure the patient is started on the appropriate therapy. The orthopedic and trauma surgeons should communicate clearly with the primary care physicians the need to explore and address the relevant causes.

Genetics and nutrition contribute to the rapid phase of bone loss in postmenopausal women and the slow phase of bone loss in aging women and men.[32] These factors appear to be largely the result of estrogen deficiency. Estrogen is a hormone that is important throughout life to support bone development and maintenance in both men and women. Drugs, such as antiresorptives, that prevent bone breakdown have been effective in reducing the risk of future fractures. These drugs not only slow any further deterioration of the skeleton, but also allow for some repair and restoration of bone mass and strength. However, they cannot completely restore mechanical integrity because of the absence of an anabolic effect.

There are several possible barriers to implementation of this protocol in the current healthcare setting. The most notable is provider education. Healthcare providers of fragility fracture patients will need to be well educated on the protocol for it to be effective. These healthcare providers include orthopedic physicians, emergency room physicians, emergency room physician extenders, orthopedic mid-level providers, primary care providers, resident physicians, and nurses. After adequate education, the protocol implementation could be subjected to improvements that would incorporate potential patients into all aspects of the protocol. Another potential barrier was identified through a survey of physicians which was cost of the workup necessary for osteoporosis.[54] Communication between orthopedic surgeons and primary care physicians also has been identified as a barrier that needs to be addressed.[55] Increasing awareness of the responsibility and the opportunity providers have to make a substantial impact on this clinical problem would prevent secondary fragility fractures and decrease the morbidity and mortality of patients with underlying metabolic bone disease. Other potential barriers include cost of therapy, patient reluctance, time and cost of diagnosing osteoporosis, special patient populations (e.g., uninsured or underinsured, minorities) gender differences, lack of access to BMD testing, and a lack of time to address secondary prevention.[56-57]

Comprehensive secondary prevention should consist of osteoporosis assessment and treatment together with a fall risk assessment. With this protocol, secondary fragility fractures could be prevented.

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Keywords: metabolic bone disease, bone fractures, osteoporosis, secondary prevention.

KANSAS JOURNAL of MEDICINE

CASE REPORT

The Use of Precision Alignment Technology to Circumvent Patient-Specific Roadblocks in Performing Total Knee Arthroplasty: A Case Series

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INTRODUCTION

The goal of total knee arthroplasty (TKA) is to provide the patient with a well-functioning, pain-free knee that will last for many years. To improve implant survival, the goal is to position the prosthesis in a way that restores proper biomechanical alignment, and advances in technology have enabled arthroplasty surgeons to produce accurate results on a more consistent basis. One of these advances is the use of computer-assisted orthopaedic surgery (CAOS) to assist in proper component alignment and produce accurate restoration of the biomechanical axis consistently.[1-17] Functional scores and revision-free survival are at least equivalent to conventional arthroplasty.[17-26]

Traditional cutting guides for TKA rely on intramedullary femoral instruments, and either intramedullary or extramedullary tibial instruments, to obtain proper axial alignment. In cases where retained hardware is present, or in patients with knee osteoarthritis associated with pre-existing femoral or tibial extra-articular deformity, CAOS has proved to be an exceptionally useful, effective, and appealing option.[27-37] A portable, accelerometer-based navigation device (OrthAlign, OrthAlign Inc., Aliso Viejo, CA) for TKA has demonstrated promising results with regard to the alignment accuracy of large-console CAOS systems.[10-14]

We present three patients who underwent TKA with retained femoral hardware. Two patients had intramedullary femoral fixation and one patient had an interference screw from a previous anterior cruciate ligament (ACL) reconstruction that would interfere with the use of a conventional intramedullary alignment guide. A novel, portable, accelerometer-based navigation (OrthAlign® precision alignment system, OrthAlign Inc., Aliso Viejo, CA) guide enabled performance of TKA without the need for surgical removal of hardware.

CASE REPORT

Case #1. A 52-year-old female (Body Mass Index (BMI): 35.1 kg/m2) presented with a chief complaint of right knee pain (Knee Society Score: 57 and functional Knee Society Score: 50). She had a remote history of right intertrochanteric hip fracture treated surgically with a long antegrade cephalomedullary fixation nail. Her fracture proceeded to union, and she was able to bear full weight on the affected extremity. Since her previous surgery, however, she developed anterior and lateral right knee pain accompanied by crepitation. Rest, ice, heat, nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen were used to control her pain but were not successful. Physical examination of her right knee showed correctable valgus deformity and tenderness to palpation both anteriorly and laterally. Her active range of motion was from 0° to 110° of flexion, and she had a mild effusion with crepitus throughout a range of motion. Radiographs showed patellofemoral and lateral compartment joint space narrowing, subchondral sclerosis, and osteophyte formation (Figure 1). The presence of a long antegrade cephalomedullary nail with two distal interlocking screws also was noted.

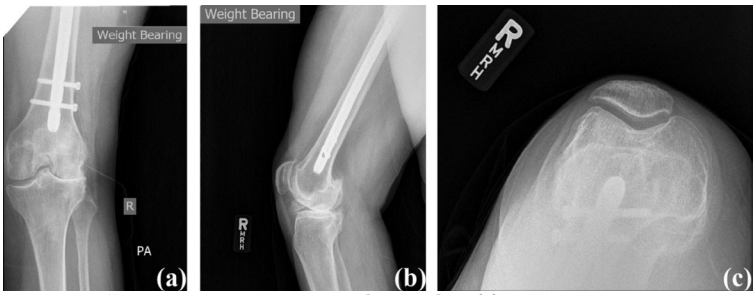

Figure 1. Case #1 pre-operative radiographs: (a) anterior posterior view, (b) lateral view, and (c) sunrise view.

Given the presence of the long antegrade cephalomedullary fixation nail, a decision was made to use the OrthAlign® precision alignment system to assist in positioning the bone cuts to obviate the need to extract the femoral hardware prior to TKA. During surgery, a standard midline incision was used with a medial parapatellar arthrotomy. Surgery proceeded as usual with the addition of the use of the OrthAlign® precision alignment system to determine the femoral and tibial cuts. The Movation™ system (DJO, LLC, Vista, CA), a posterior stabilized knee system, with femoral size 4, tibia base plate size 2, patella size 32, and an 11 mm posterior, stabilized polyethylene insert was used. Palacios bone cement with vancomycin also was used. Surgical course was without complication. Total tourniquet time was 41 minutes at 300 mmHg.

Her post-operative course was without complication. She was mobilized and ambulated with physical therapy. She was discharged home on post-operative day two with a prescription for outpatient physical therapy. At six weeks post-operatively, her incision had healed without any complications, her passive range of motion was 0° - 125° and was pain free (Knee Society Score: 100 and functional Knee Society Score: 85). Her knee was stable on exam and well-aligned, radiographically (Figure 2). She was walking unlimited distances with a cane, and she was using stairs in a reciprocal manner. Her next follow-up visit was scheduled for six months after surgery.

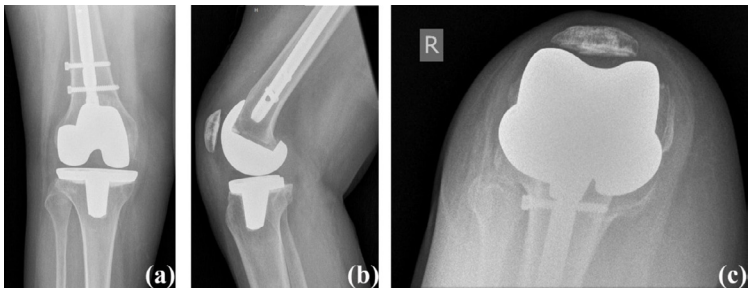

Figure 2. Case #1 post-operative radiographs: (a) anterior posterior view, (b) lateral view, and (c) sunrise view.

Case #2. A 62-year-old female (BMI: 20.8 kg/m2) presented with a chief complaint of right knee pain (Knee Society Score: 52 and functional Knee Society Score: -10). She was a poly-trauma victim, suffering a boating accident ten months prior. She sustained numerous fractures including the spine, pelvis, femur, ankle, and clavicle which required open reduction and internal fixation. Her right femur was treated with a retrograde femoral nail with three distal interlocking screws. Despite the treatment, her right knee pain progressively had been worsening, and was associated with crepitus throughout her range of motion. The use of stairs, as well as prolonged standing and walking, exacerbated her pain. Her pain had not been relieved with conservative treatment measures, or corticosteroid injections. She also noted some discomfort over the two lateral-to-medial distal interlocking screws and requested that these be removed during surgery. Physical examinations revealed a correctable varus deformity of the right knee and active range of motion was from 10° to 105°, accompanied by crepitation. A moderate effusion also was noted along with tenderness along the medial joint line. Radiographs showed a healed fracture of the distal femur at the metaphyseal-diaphyseal junction, and a retrograde femoral nail is visualized with two proximal and three distal interlocking screws (Figure 3).

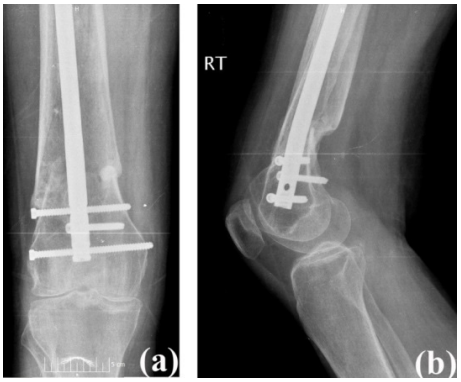

Figure 3. Case #2 pre-operative radiographs: (a) anterior posterior view and (b) lateral view.

The presence of the retrograde femoral nail precluded the use of a conventional intramedullary alignment guide. Therefore, navigation-assisted TKA was performed. The two symptomatic distal interlocking screws were removed percutaneously. The Donjoy© surgical foundation cruciate retaining (CR) knee system with femoral size 6, tibia base plate size 4, patella size 32, and an 11 mm standard CR polyethylene insert was used. Surgical course was without complication. Total tourniquet time was 48 minutes at 300 mmHg.

The patient was discharged to skilled nursing on post-operative day two for continued physical therapy for approximately two weeks after surgery. She was dismissed home with a prescription for outpatient physical therapy. At six weeks post-operatively, her active range of motion was from 0° to 125° and pain free (Knee Society Score: 100 and functional Knee Society Score: 90). Radiographs showed well-aligned components and restored mechanical axis (Figure 4). She was walking unlimited distances without any assistive device and using stairs in a reciprocal manner with a rail. Her follow-up visit was scheduled for six months after surgery.

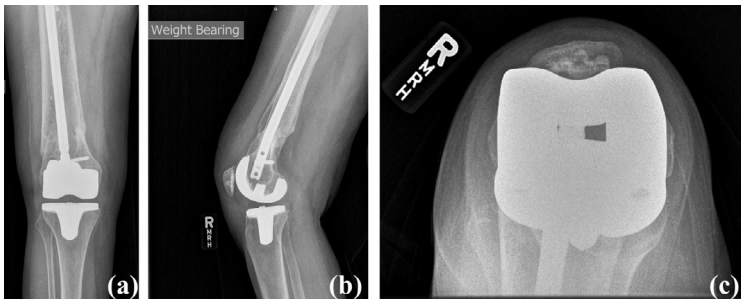

Figure 4. Case #2 post-operative radiographs: (a) anterior posterior view, (b) lateral view, and (c) sunrise view.

Case #3. A 60-year-old male (BMI: 31.0 kg/m2) presented with a chief complaint of left knee pain. The patient sustained an ACL rupture while playing sports 20 years prior and subsequently underwent an ACL reconstruction. He presented with anterior and lateral left knee pain that was dull, aching, and throbbing, and it progressively had been worsening (Knee Society Score: 56 and functional Knee Society Score: 50). His pain had not been relieved with conservative treatment measures, or corticosteroid injections. Physical examination revealed a 5° valgus deformity with range of motion from 5° to 120° of flexion accompanied by crepitation on lateral and patellofemoral compartment, as well as tenderness to palpation. He was limited to ambulating two to five blocks at a time, and the use of stairs as well as prolonged standing and walking exacerbated the pain. Radiographs showed loss of lateral and patellofemoral compartment joint space with significant sclerosis, osteophyte formation, and retained screws in both the femur and tibia as well as a staple in the tibia from previous ACL reconstruction (Figure 5).

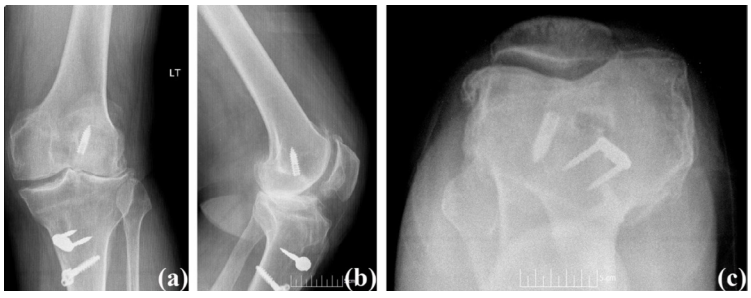

Figure 5. Case #3 pre-operative radiograph: (a) anterior posterior view, (b) lateral view, and (c) sunrise view.

During surgery, it was determined that the tibial screw and staple would need to be removed for placement of the tibial component, and removal of the screw and staple were incorporated as part of the patient's standard midline incision and medial parapatellar arthrotomy. Given the presence of the femoral interference screw, the navigation-assisted system was used to assist in making accurate bony cuts, orient the implants, assess the soft tissue balancing, and to obviate the need for the screw removal prior to TKA. A posterior stabilized implant was employed, and after making the box cut on the femoral side, the interference screw was protruding about 1 cm into the femoral box; therefore, it was removed. The Movation™ system (DJO, LLC, Vista, CA), a posterior stabilized system with femoral size 8, tibia base plate size 8, patella size 35, and a 9 mm posterior stabilized polyethylene insert and 14 mm tibial modular stem were used. The remainder of the surgical course was without complication. Total tourniquet time was 63 minutes at 300 mmHg.

At six weeks post-operatively, his knee range of motion was from 0° to 130° of flexion and pain free (Knee Society Score: 100 and functional Knee Society Score: 90). Radiographs showed well-aligned components and restored mechanical axis (Figure 6). He was walking unlimited distances without any assistive device, and he was using stairs in a reciprocal manner with a rail. His follow-up visit was scheduled for six months after surgery.

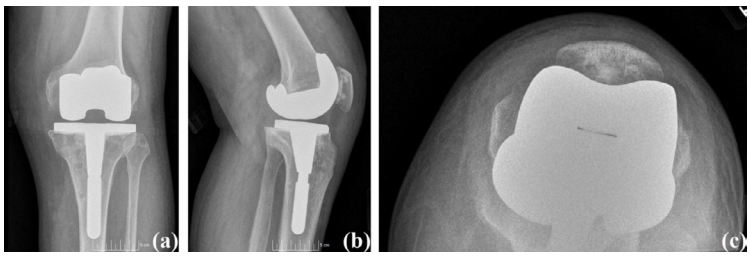

Figure 6. Case #3 post-operative radiographs: (a) anterior posterior view, (b) lateral view, and (c) sunrise view.

DISCUSSION

CAOS can be an effective tool to align TKA component and produce accurate restoration of the biomechanical axis consistently for cases when traditional instrumentation is not possible or appropriate due to post-traumatic femoral deformity, retained femoral hardware, a history of osteomyelitis, or severe cardiopulmonary disease.[27-37] In this report, the rationale for the use of navigation-assisted systems in these three cases was appropriate because they allowed establishment of the biomechanical axis and did not require hardware removal. The use of navigation-assisted system had no adverse impact on the patient's total time in the operating room or tourniquet time. The post-operative course was not adversely affected, and all three patients' pain and function were improved at six-week follow-up.

Based on these results, navigation-assisted systems present physicians with an effective option for performing TKA in patients with pre-existing hardware. It obviated the need for a prior surgery to remove the retained implant, saving the patient the risk and subsequent morbidity of a second surgery and conceivably improving patient rehabilitation and outcomes. Furthermore, it also reduced the cost to the patient and the health care system through decreased number of surgeries and total operating room time. Although long-term follow-up was not available, the post-operative course was uneventful. Further research using randomized, prospective studies would be beneficial to compare outcomes in single-stage TKA using navigation-assisted versus two-stage surgery with hardware removal.

In summary, navigation-assisted TKAs with retained femoral hardware were successful and safe. The advantages of the navigated-assisted TKA for normal cases remain a matter of debate, however, navigation-assisted TKA was an excellent alternative for hardware retaining cases.

ACKNOWLEDGEMENT

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CONFLICT OF INTEREST STATEMENT

This study uses the OrthAlign® precision alignment system from OrthAlign Inc. (Aliso Viejo, CA). However, OrthAlign Inc. had no role in the collection, analysis and interpretation of data, writing of the manuscript, or decision to submit the manuscript for publication. This study did not receive any payments or other personal benefits or a commitment or agreements that were related in any way to the subject of the current research project.

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Keywords: total knee arthroplasty, orthopedic procedures, orthopedic devices

KANSAS JOURNAL of MEDICINE

CASE REPORT

Congenital Coronary Artery Anomaly in an Asymptomatic Patient Presenting with Cardiac Arrest

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INTRODUCTION

Coronary artery anomalies are thought to be present in 0.2% to 1.2% of the general population.[1] Origin of the left main coronary artery from the pulmonary artery (ALCAPA), also known as Bland-White-Garland syndrome, is a rare coronary artery anomaly (one in 300,000 live births) where the left main coronary artery branches from the pulmonary artery and is unable to supply oxygenated blood to the left side of the heart.[2,3] The clinical presentation of ALCAPA can vary and may present with myocardial ischemia or infarction in children. These ischemic events are thought to be caused by the drop in pulmonary vascular resistance shortly after birth coupled with decreased pulmonary arterial pressure and anterograde flow through the left coronary artery. This can lead to a "coronary steal" phenomenon where collateral flow from the right coronary artery fills the left main system but the myocardium, overall, remains inadequately perfused. These patients, if left untreated, can have a mortality of up to 90% in the first year of life.

While there are very little data about long term outcomes, early identification and surgical correction is believed to lead to a good prognosis and myocardial tissue recovery.[4] While ALCAPA is mainly a pediatric disease, approximately 10 - 15% of all cases can present in adults where survival is determined by the dominance of the right coronary artery (RCA) and the level of inter-coronary collaterals. There is an estimated sudden death rate among these cases of 80 - 90% at the mean age of 35.[4,5]

CASE REPORT

A 48-year-old asymptomatic Caucasian female with no prior significant medical history was transferred to the University of Kansas Medical Center in critical condition. The patient collapsed after dancing in a club and cardiopulmonary resuscitation was performed for approximately 6 - 8 minutes. The presenting rhythm was ventricular fibrillation and two rounds of electrical cardioversion were administered after which return of circulation was achieved. The patient was transported by emergency medical services and reported to be stable during transport, but was in ventricular fibrillation at the time of hospital arrival. Two more rounds of electrical cardioversion were administered successfully as the patient returned to sinus rhythm.

At arrival to the hospital, the patient was intubated and therapeutic hypothermia treatment was initiated. Urine drug screen was positive for cannabinoids and alcohol level was less than 10 mg/dL. Brain natriuretic peptide (BNP) was elevated to 859 pg/ml; initial troponins were 0.12 (normal < 0.05). A 2-dimensional (2D) Doppler echocardiogram demonstrated severely depressed systolic function and global hypokinesis with an estimated 15% ejection fraction (EF).

Computed tomography (CT) imaging of the head and spine showed no abnormalities while an electrocardiogram showed a 2 mm ST depression in the lateral leads without any significant T wave changes. The patient was taken urgently for heart catheterization. No significant atherosclerotic lesions were found, but she had a large right coronary artery with collaterals filling the left coronary system (Figure 1). A CT coronary angiogram demonstrated the origination of the left main coronary artery from the main pulmonary artery (Figure 2). A dominant right coronary artery was noted again providing collaterals to the left coronary circulation. A diagnosis of anomalous left coronary artery from the pulmonary artery (ALCAPA) was established.

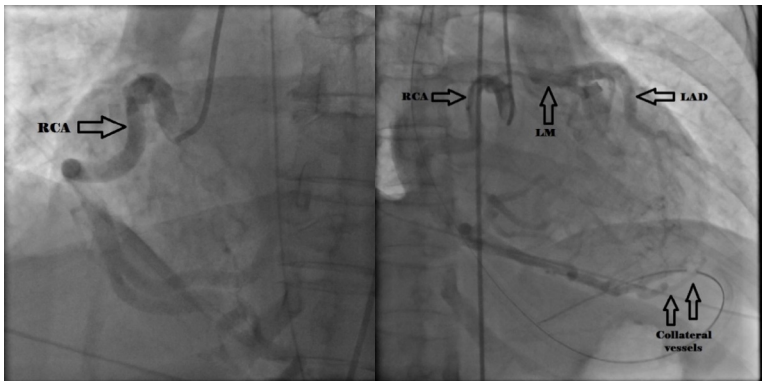

Figure 1. Sequential images from coronary angiography demonstrated contrast injection (left) into a dilated right coronary artery (RCA) with flow via (right) collateral vessels into the left anterior descending (LAD) and left main coronary arteries (LM).

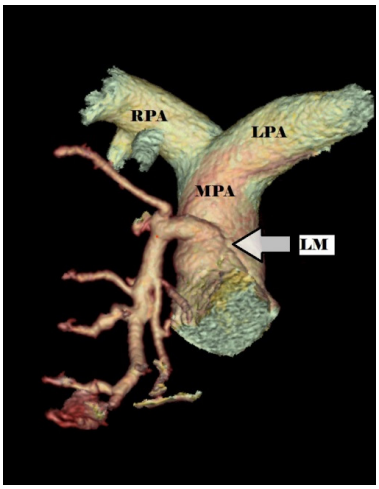

Figure 2. CT reconstruction illustrated left main coronary artery (LM) originating from main pulmonary artery (MPA). Right pulmonary artery (RPA) and left pulmonary artery (LPA) branched off the MPA.

The case was discussed with the cardiothoracic surgery team who recommended a viability study before evaluation for surgery for possible revascularization. Accordingly, a resting and delayed myocardium viability study was ordered two days after initial cardiac arrest to guide surgical treatment options. Surprisingly, the stress thallium study demonstrated normal viability in all segments (Figure 3). To corroborate the viability study findings, a follow-up 2D Doppler echocardiogram three days after cardiac arrest showed normal systolic function and a recovered EF at 50%. The patient was extubated on day two of hospitalization and had no notable neurologic sequela from cardiac event.

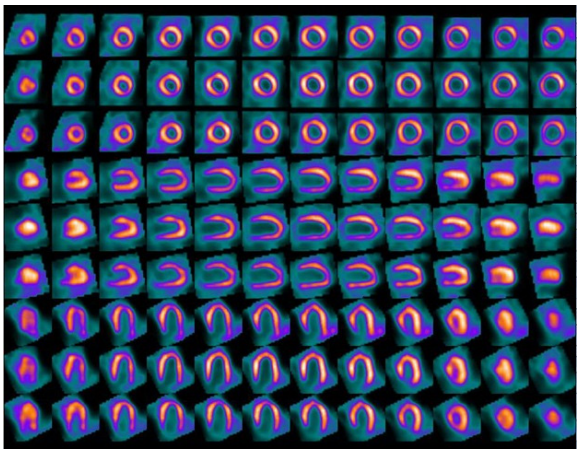

Figure 3. Resting thallium study (24 hours post injection) demonstrated no marked perfusion defects.

The patient's in-hospital recovery was unremarkable other than a few episodes of non-sustained ventricular tachycardia on day four of hospitalization. There were several issues complicating a surgical intervention in our patient as she was from out of state and in town for a family visit, uninsured, and preferred to go back home for any major surgical procedure. After extensive discussions between the multi-disciplinary medical team and the patient, it was decided that the patient would receive her surgical intervention in her home state and an appointment was made with a cardiothoracic surgeon there. A single chamber implantable cardioverter defibrillator (ICD) device was placed for secondary prevention of sudden death from cardiac arrest before discharge on day six of hospitalization.

DISCUSSION

ALCAPA in adults presents with a varying degree of symptoms such as dyspnea at rest or with exertion, syncope, cardiac palpitations or arrhythmias, and angina pectoris.[6] Our patient denied experiencing any of those symptoms prior to her sudden cardiac arrest episode owing most likely to sufficient blood flow via collateral vessels via the enlarged RCA (Figure 1). Only a handful of cases have been reported where the presenting symptom for a patient with ALCAPA has been a ventricular arrhythmia precipitated by activity, as is the case for our patient.[7,10]

Two mechanisms have been proposed as the cause of these arrhythmias.[7] First, hypo-perfusion due to the coronary anomaly could cause a small myocardial infarction which would lead to scar formation and alteration of the conduction system. Second, an arrhythmia could be triggered by an acute ischemic episode during exercise or strenuous physical activity. The latter most likely would explain our patient's presentation. The transient ischemic event experienced by our patient most likely was induced by her increased level of activity. This sudden increase in activity seems to be atypical for our patient as she was overweight and reported a very sedentary lifestyle for most of her adult life. These cases seem to indicate the presence of sufficient collaterals is a deterrent for symptoms, but does not seem to protect against sudden cardiac arrest due to ventricular arrhythmias.[7]

Surgical correction of the anomaly soon after diagnosis is considered optimal treatment and most techniques aim to establish a two coronary system.[7,8] Mitral regurgitation is a common consequence of ALCAPA and thought to result from ischemic damage to papillary muscles, but there is insufficient evidence if simultaneous mitral valve replacement with surgical anomaly correction leads to better outcomes.[11] Some cases have been reported where surgical correction of the anomaly was not undertaken and medical management was considered more appropriate due to the patient's age, comorbidities, and level of collateralizations among other factors.[6,9] While our patient did not fall in that group, due to circumstances surrounding the case and personal preferences as discussed, the patient was discharged with an ICD device and would follow-up in her home state for a surgical intervention to establish a two coronary system.

In summary, ALCAPA is a rare subset of coronary anomalies and awareness of it can be essential when dealing with arrhythmias in the absence of atherosclerotic heart disease. Early diagnosis and treatment can yield promising results. Our patient had been asymptomatic prior to her episode of sudden cardiac arrest, likely due to sufficient blood flow from her enlarged right coronary collateral vessels. Surgical correction of the anomaly soon after diagnosis is considered optimal treatment and most techniques aim to establish a two coronary system. Our case presented not

only a rare condition in ALCAPA but an uncommon presentation in an asymptomatic adult patient with a sudden cardiac arrest.

ACKNOWLEDGMENT

The authors would like to thank the radiology department at the University of Kansas Medical Center for their assistance with reviewing the images used in this case.

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Keywords: ALCAPA, Bland White Garland Syndrome, coronary vessel anomalies, heart arrest

Contralateral Pneumothorax after the Implantation of a Dual Chamber Pacemaker

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An 85-year-old male presented to the primary care clinic with a one-month history of excessive fatigue and one episode of almost fainting. An electrocardiogram showed Mobitz II second degree heart block with a pulse rate of 36 beats per minute. He was admitted and cardiology was consulted for further work-up and management. His past medical history was significant for diabetes mellitus, hypertension, hyperlipidemia, hypothyroidism, and peripheral vascular disease. Initial laboratory tests showed a normal thyroid profile, complete blood count, liver panel, and renal function panels. His troponin was <0.04 u/dl. With no reversible causes of heart block identifiable, he was scheduled for a permanent pacemaker insertion.

He had a dual chamber Medtronic permanent pacemaker placed and remained admitted for overnight observation. The patient complained of substernal chest pain the next day but no shortness of breath. A CT scan showed a pacemaker lead perforating the right atrial myocardium causing right pneumothorax and slight mediastinal shift to the left (Figures 1 and 2). Interrogation of the pacemaker revealed the atrial lead was not capturing and had high impedance. The pacemaker lead was pulled and repositioned in a different location in the right atrium. The patient had a chest tube with underwater seal drainage with resolution of pneumothorax.

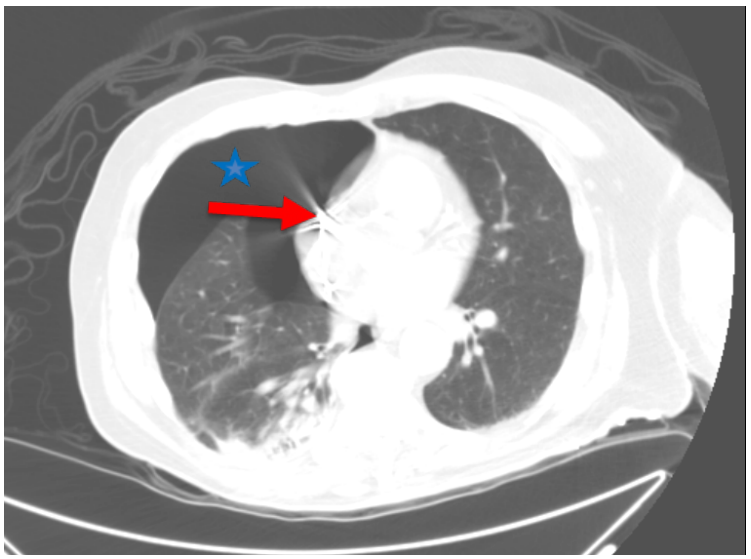

Figure 1. CT scan of the chest showing right-sided pneumothorax (blue star) and the tip of pacemaker lead perforating the myocardium (red arrow).

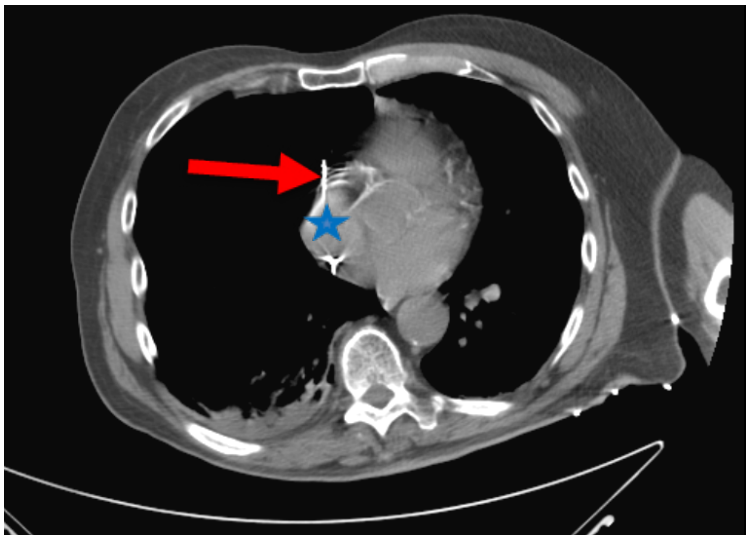

Figure 2. CT scan of the chest showing the tip of the pacemaker lead (red arrow) perforating through the right atrium (blue star).

DISCUSSION

Acute complications of transvenous insertion of pacemakers and dual chamber implantable cardioverter defibrillators (ICD) are rare but often serious when they occur. The reported incidence of right ventricular perforation is 0.6 - 6%.[1,2] Contralateral pneumothorax is one such rare complication with a reported incidence of 1%.[3,4] The reported risk factors for perforation included steroid use, use of a helical screw-in lead, and use of transvenous temporary pacing in one series.[5] The diagnosis is made when, at a minimum, the tip of a passive fixation lead or the screw of an active fixation lead passes through the myocardium and extends into the pericardial cavity.[6] The presentation of myocardial perforation is variable. Large pericardial effusions and tamponade are observed less than anticipated, perhaps due to a combination of slowed leakage from the low pressure chamber (right atria and ventricle), self-sealing properties of the ventricle wall by muscle contraction, fibrosis, or by the lead itself.[7,8]

The management of lead perforation is not standardized and includes lead repositioning or lead extraction for patients with severe symptoms.[9] Our patient had clinically significant pneumothorax and had to have a chest tube placement. Repositioning of the lead was sufficient in this case and no recurrence of pneumothorax was noted upon follow-up.

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