Current femoral stem fixation in hip arthroplasty for hip fractures after the revised national guidelines in Japan: a questionnaire survey in a super-aging prefectural area

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Abstract

Background

The Japanese guidelines for the management of hip fractures were most recently revised in 2021 to recommend the use of cemented stems in cases of bone fragility. However, the selection of cementless or cemented stem fixations remains controversial. This study aimed to examine the current stem selection strategy in bipolar hemiarthroplasty, concerns about using cemented stems, and factors affecting the ability to instruct cemented stems.

Methods

This study included 94 orthopedic surgeons from 27 facilities who answered a web-based questionnaire survey of 15 questions in the super-aging prefectural area in Japan from January to February 2022. Multiple logistic regression analysis was used to identify the factors associated with the ability to instruct the cemented stem. The cutoff value for the number of cemented stem usage experiences that can be used to instruct cemented stems was determined using the receiver operating characteristic (ROC) curve.

Results

A total of 97.8% of doctors answered that the cementless stem was the current first choice, and 83.0% of doctors had only 0–10 cases of the cemented stem. Meanwhile, only 14.9% of doctors are expected to increase the use of cemented stems in the future. The cement technique was the greatest concern regarding the use of cement stems (60.6%). On multivariate analysis, the number of surgeries of the cemented stem was the factor most affecting the ability to instruct the cemented stem (odds ratio: 8.42, p=0.001). In the ROC curve analysis for the capability of instructing cemented stems and the number of surgeries using cemented stems, the best cutoff value was 1–10 cases (sensitivity, 94.4%; specificity, 58.6%), with an area under the curve of 0.8448 (95% confidence interval: 0.7754–0.9142). When the cut-off value was 11–50 cases, the specificity was higher (sensitivity, 41.7%; specificity, 98.3%).

Conclusions

A few doctors still select cemented stems as the first choice. The number of surgeries on the cemented stem was the factor most affecting the ability to instruct the cemented stem, and more than 11 cases are desirable.

Background

For the treatment of displaced femoral neck fractures, hip arthroplasty has good results compared to internal fixation, with earlier mobilization, fewer reoperations, and better functional outcomes(1,2). However, the selection of cementless or cemented stem fixations remains controversial(3,4). Cementless stems have the advantages of reduced blood loss, shorter operative time, and no risk of cardiovascular

events associated with cement use(3–6), and their use in total hip arthroplasty is increasing worldwide(7).

However, cementless stems have a higher risk of intraoperative and postoperative periprosthetic fractures than cemented stems,(5,8,9) and guidelines in the United States and the United Kingdom recommend the use of cemented stems for elderly hip fractures(10,11). Furthermore, the Japanese guidelines for the management of hip fractures were revised in 2021 to recommend the use of cemented stems in cases of bone fragility(12). Therefore, the use of cemented stems in Japan may increase in the future, according to the revised guidelines. However, cemented stems require a careful technique to achieve good long-term results(13–15), and the choice of a stem may involve multiple factors, including the surgeon and the senior surgeon's policies, preferences, specialty, and experience.

Hip fractures are increasing with the aging of the population, and it is important to know the current stem selection strategies and factors associated with the ability to instruct cemented stems in this super-aging prefectural area with 38.1% aged > 65 years(16). Therefore, this study aimed to report the stems used by hip surgeons for femoral neck fractures in 2021 after the revision of the guidelines and to examine the current stem selection strategy, concerns about using cemented stems, and factors affecting the ability to instruct cemented stems by a questionnaire survey to orthopedic surgeons.

Methods

A web-based questionnaire via Google Forms was sent to orthopedic surgeons working in medical institutions (including university hospitals, community hospitals, and clinics) in this region of the 930,000 population. The questionnaire was designed by three board-certified orthopedic surgeons by the Japanese Orthopedic Association and specializing in hip joints. The questionnaire was composed of 15 questions, and the questions are shown in Table 1 (Table 1).

Table 1
Questionnaire used in this study

Q.1 How many years of experience do you have as an orthopedic surgeon? (free description)
Q.2 What is your orthopedic specialty areas
☐ Spine ☐ Hip ☐ Upper limb ☐ Knee ☐ Foot & Ankle ☐ Other
Q.3 How many BHA have you performed?
☐ >50 ☐ 11–50 ☐ 1–10☐ 0
Q.4 How many surgeries using cemented femoral stem have you performed?
☐ >50 ☐ 11–50 ☐ 1–10☐ 0
Q.5 What is your current first choice of cement or cementless fixation of femoral stem in BHA?
☐ cement ☐ cementless
Q.6 The reason of current femoral stem fixation choice (multiple choice)
☐ familiar technique ☐ good initial stability ☐ longer survival rate ☐ less complication ☐ other (free description)
Q.7 Have you experienced any complications with cementless femoral stems.
☐ Yes ☐ No
Q.8 If yes in Q.5, what complications have you experienced? (multiple choice)
☐ intraoperative or early postoperative periprosthetic fracture ☐ subsidence ☐ loosening ☐ malposition of implant ☐ other (free description)
Q.9 Which of the following cases would you consider using cemented stem? (multiple choice)
☐ wide femoral canal ☐ porotic bone ☐ comminuted fractures ☐ other (free description) ☐ do not use cemented stem
Q.10 Have you experienced any complications with cemented femoral stems?
☐ Yes ☐ No
Q.11 If yes in Q.9, what complications have you experienced? (multiple choice)
☐ intraoperative or early postoperative periprosthetic fracture ☐ subsidence ☐ loosening ☐ malposition of implant ☐ other (free description)
Q.12 What are your concerns about using cemented femoral stem? (multiple choice)

BHA, bipolar hemiarthroplasty; BCIS, bone cement implantation syndrome

Q.1 How many years of experience do you have as an orthopedic surgeon? (free description)
☐ cement technique ☐ implant position ☐ cement-hardened before stem insertion ☐ longer operation time ☐ BCIS ☐ other (free description)
Q.13 Will you increase the use of cemented femoral stem according to revised national guidelines?
☐Yes, I will firstly choose cemented stem ☐ Yes, I will increase the cemented stem ☐ Partly agree, I will choose cemented stem if necessary ☐No, I will only use cementless stem.
Q.14 Can you instruct cemented stem to other orthopedic surgeons?
☐ Yes ☐ Possible, depending on experience of surgeon ☐ No
Q.15 What are your concerns about instructing cemented stem? (multiple choice)
☐ management of intraoperative fracture ☐ management of implant-malposition ☐ less experience of cemented stem ☐ other (free description)
BHA, bipolar hemiarthroplasty; BCIS, bone cement implantation syndrome

We surveyed the characteristics of the participants, their experience of bipolar hemiarthroplasty (BHA) and cemented stem, the current first choice of stem fixation, complications, concerns about cemented stem usage, and capability of instructing cemented stem to other orthopedic surgeons. The experiences of BHA and cemented stems were classified into four categories: 0, 1–10, 11–50, and 51 or more cases. The survey period was from January 14–to February 31, 2022. All collected questionnaires were tabulated by the author (T.M.). Furthermore, the femoral stems used in the BHA for femoral neck fractures from January to December 2021 at nine institutions with hip surgeons were examined. We classified the femoral stems according to the cementless and cementless short stem classifications of Khanuja et al. (17,18). Cemented and full hydroxyapatite (HA)-coated stems were also classified separately.

All continuous variables are expressed as mean ± standard deviation (SD), and categorical variables are expressed as percentages. Chi-squared tests were used to compare the proportion of complications experienced by the cementless and cemented stems. Multiple logistic regression analysis was used to identify factors associated with the ability to instruct the use of cemented stems to other orthopedic surgeon. The cutoff value for the number of cemented stem usage experiences that can be used to instruct cemented stems was examined using the receiver operating characteristic (ROC) curve. The results were verified using R version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at $p < 0.05$.

Results

Questionnaire survey

In total, 94 (86 males and 8 females) from 27 facilities completed the questionnaires during the study period, with a response rate of 53.7%. Fifteen doctors were from a university hospital, 74 doctors from 22

community hospitals, and five doctors from five private clinics. The mean experience as an orthopedic surgeon was mean 16.6 (1–45) years, with 22.3% in the spine, 17% in the knee, 16% in the hip, 11.7% in the upper extremity, 5.3% in the foot, and 27.7% in the other (Fig. 1). Figure 2 shows the percentage of cases of BHA and cemented stems (Fig. 2). Of the doctors, 83.0% had 11 or more BHA cases. However, 38.3% of doctors had never performed cemented stem BHA and 44.7% of doctors had 1–10 cases. Therefore, 83.0% of the doctors had fewer than 10 cases of cemented stems.

In Q.5, 97.8% of doctors answered that the cementless stem is the current first choice in BHA. The most common reason for choosing cementless fixation was familiarity with the technique (88.2%). A total of 18.1% reported fewer complications, 5.3% answered longer survival rate, and 3.2% reported good initial stability. The free description included unfamiliarity with cemented stems, not feeling the necessity of using cemented stems, and concern about pulmonary embolization with cemented stems. In Q.7, 57.4% of doctors answered that they experienced complications during the cementless stem, whereas in Q.10, only 17.0% of doctors experienced complications during the cemented stem. Table 2 shows the results of the comparison of the complication experience between the cementless and cemented stems (Table 2). Significantly more doctors experienced intraoperative or early postoperative periprosthetic fractures (75.9% vs.12.5%, $p < 0.001$) and subsidence (37.0% vs.0%, $p = 0.003$) in cementless stems. However, malposition of the implant (1.9% vs.37.5%, $p < 0.001$) and other complications (7.4% vs.68.8%, $p < 0.001$) were more common in cemented stems. Other complications included cementing techniques, such as early cement hardening and a lack of cement mantle. In Q.9, which questions in which cases the use of cemented stem is advisable, 48.9% doctors answered the wide femoral canal, 34.0% the porotic bone, 26.6% comminuted fractures, and 18.1% did not use the cemented stem in any cases. In Q.12, 60.6% of doctors answered the cement technique as concerns using cemented stems, 54.2% cement-hardened before stem insertion, 48.9% implant position, 43.6% bone cement implantation syndrome, and 21.3% longer operative time. In Q13, 3.2% doctors answered, “firstly choose cemented stem” and 11.7% answered “I will increase the cemented stem.” Therefore, most doctors still preferred using cementless stems (partly agree, I will choose cemented stem if necessary: 83.0%; only use cementless stem: 2.1%).

Table 2
Comparison of complication rates between cementless and cemented stems

	Cementless	Cemented	p value
n	54	16	
intraoperative or early postoperative periprosthetic fracture	41 (75.9)	2 (12.5)	< 0.001
Subsidence	20 (37.0)	0 (0)	0.003
Loosening	8 (14.8)	1 (6.3)	0.369
Malposition of implant	1 (1.9)	6 (37.5)	< 0.001
Others	4 (7.4)	11 (68.8)	< 0.001
Data are presented as n (%).			

In Q.14, 39.3% of doctors answered that it was possible to instruct the cemented stem (19.1% answered yes and 20.2% answered depending on the experience of the surgeon), and 91.3% of the facilities (23 facilities in total without clinics) were affiliated with the surgeon. However, 41.5% of doctors felt less experience with cemented stems, 30.9% were concerned about the management of implant malposition, and 8.5% were concerned about the management of intraoperative fractures.

In the univariate analysis to investigate factors associated with the capability of instructing cemented stem, years of experience as an orthopedic surgeon (odds ratio [OR], 1.10; $p < 0.001$), hip surgeon (OR, 17.82; $p < 0.001$), number of surgeries of BHA (OR, 2.44; $p = 0.005$), and number of surgeries of the cemented stem (OR, 13.31; $p < 0.001$) were identified. On multivariate analysis, experience as an orthopedic surgeon (OR, 1.10; $p = 0.005$) and the number of surgeries on cemented stems (OR, 8.42; $p = 0.001$) were factors affecting the ability to instruct cemented stems (Table 3). In the ROC curve analysis for the capability of instructing cemented stems and the number of surgeries using cemented stems, the best cutoff value was 1–10 cases (sensitivity, 94.4%; specificity, 58.6%), with an area under the curve of 0.8448 (95% confidence interval:0.7754–0.9142). When the cutoff value was 11–50 cases, the specificity was higher (sensitivity, 41.7%; specificity, 98.3%) (Fig. 3).

Table 3
Univariate and multivariate analyses of factors affecting the ability to instruct cemented stems

	Univariate			Multivariate		
Variables	OR	95%CI	p value	OR	95%CI	p value
Years of experience as an orthopedic surgeon	1.10	0.11–1.10	< 0.001	1.10	1.03–1.18	0.005
Hip surgeon	17.82	4.51–119.6	< 0.001	8.39	1.12–92.90	0.052
Number of surgeries of BHA	2.44	1.36–4.79	0.005	1.68	0.83–3.57	0.157
Number of surgeries of cemented stem	13.31	4.91–55.14	< 0.001	8.42	2.73–37.59	0.001
BHA, bipolar hemiarthroplasty; OR, odds ratio; CI, confidence interval						

Survey Of Femoral Stem Used At Facilities Employing Hip Surgeons

A total of 226 BHA procedures were performed at nine institutions in 2021. Approximately half of the cases were single-wedge stems, and only 11 cases (4.9%) were cemented stems. (Fig. 4). All short stems were type 4, with shortened conventional tapered stems (18). There were no intraoperative fractures, but two periprosthetic fracture due to a fall from the height occurred in the single wedge stem. Dislocation occurred in two single wedge stem and one tapered rectangular stem. The infection occurred in a single wedge stem.

Discussion

In this study, we reported the femoral stem used by hip surgeons for femoral neck fractures in 2021 after the revision of the guidelines and examined the current stem selection strategy, concerns about using cemented stems, and factors affecting the capability of instructing cemented stems by a questionnaire survey to orthopedic surgeons in a super-aging prefectural area. At the time of the survey, cementless stems were the first choice for 97.8% of doctors, and only 4.9% of cases used cemented stems treated by hip surgeons. Furthermore, only 14.9% of doctors are expected to increase the use of cemented stems in the future. The cement technique was the most common concern regarding the use of cemented stem at 60.6%. On multivariate analysis, the number of surgeries of the cemented stem was the factor most strongly affecting the ability to instruct the cemented stem.

Familiarity with the surgical technique and fewer complications were reasons for selecting cementless stems. However, the experience rate of periprosthetic fracture and subsidence was significantly higher in

cementless stems in our survey, and the features of cementless stems need to be recognized. In general, cementless stems do not require additional procedures for cement insertion, resulting in shorter operative times(19). Cementless stems have a large variety of designs and stabilization methods available and require optimal stem design selection to obtain good initial stability(19–21). Therefore, surgeons need to understand the principles of stem design, such as stem geometry and location of femoral fixation(17,18). In contrast, cemented stems provide good initial fixation regardless of bone morphology, less periprosthetic fractures and postoperative thigh pain, lower cost than cementless stems, and have health economic advantages(12,19,20,22). In this study, the experience rate of periprosthetic fractures was higher than that of cemented stems, and it is important for surgeons to fully recognize the differences between them.

Only 14.9% of doctors answered that they would increase the number of cemented stem usage cases in the future, and multivariate analysis indicated that to increase the use of cemented stems in this region, supervisory doctors need to have more experience with the cemented stem. At the time of the survey, 97.8% of the doctors answered that cementless stems were the current first choice. This might have resulted from the received surgical instruction with cementless stems and the experience of performing and succeeding in the surgery. However, approximately half of the doctors understand the recommended cases of using cemented stems, such as the wide femoral canal and porotic bone. Therefore, the cementing technique and management of implant malposition, which are addressed in concerns about using cemented stems, may be the reasons why cemented stems are not widely used. In fact, orthopedic surgeon trainees in the United States feel prepared to cement a femoral component, but they perceive that they do not receive sufficient training in the cement technique(23). In this region, supervisory doctors also have less experience with cemented stems and concerns about the management of implant malposition. This revealed that, in addition to the usual cement technique, cement in cement and cement methods used in stem revision procedures need to be included in training(24,25). From the ROC curve analysis to estimate the cutoff value for the capability of instructing cemented stems, the specificity was 98.3% when there were more than 11 cases of cemented stem usage experience. Since more than 11 cases are desirable as the target number of cases for supervisory doctors, establishing a sufficient education program and exploring the teaching methodologies of cementation is necessary.

This study has several limitations. The first is sampling bias. This is the result of a questionnaire survey conducted by all orthopedic surgeons in one region of Japan, and different results may be obtained depending on other regions, countries, and specialized areas of orthopedic surgeons. Second, it is difficult to survey the actual number of surgical cases of BHA and cemented stems among individual surgeons. Therefore, a survey of the actual number of surgeries is needed to determine the cutoff value to be able to teach cemented stems and produce a learning curve. Finally, the ability to instruct cemented stems is a subjective perception of individual surgeons. Further large-sample, well-designed investigations are necessary for actual teaching ability and to conduct a survey of the number of surgeries. Nevertheless, despite these limitations, we believe that this survey has clinical relevance and provides insights into general orthopedic surgeons' current practice of femoral stem fixation in BHA, cement perception, and factors affecting the instruction of the cement technique.

Conclusions

Only a few doctors are expected to increase the use of cemented stems in the future. The cement technique was the greatest concern about the use of cement stems. On multivariate analysis, the number of surgeries on the cemented stem was the factor most affecting the ability to instruct the cemented stem. Although cementless stems are associated with excellent long-term survivorship, cement stem effectiveness in some patients has become clearer. To make appropriate choices in stem selection, it is necessary to establish a sufficient education program and explore teaching methodologies for cementation.

Abbreviations

BHA: bipolar hemiarthroplasty

SD: standard deviation

ROC: receiver operating characteristic

HA: hydroxyapatite

OR: odds ratio

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Institutional Review Board of Tazawako Hospital (approval No. 2022-3). This study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

TM collected data and drafted the manuscript. HK and HT designed the study and supervised the study. NM supervised the project and gave final approval. All authors had complete access to all data used in this study and took responsibility for its accuracy. All the authors have read and approved the final manuscript.

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Figures

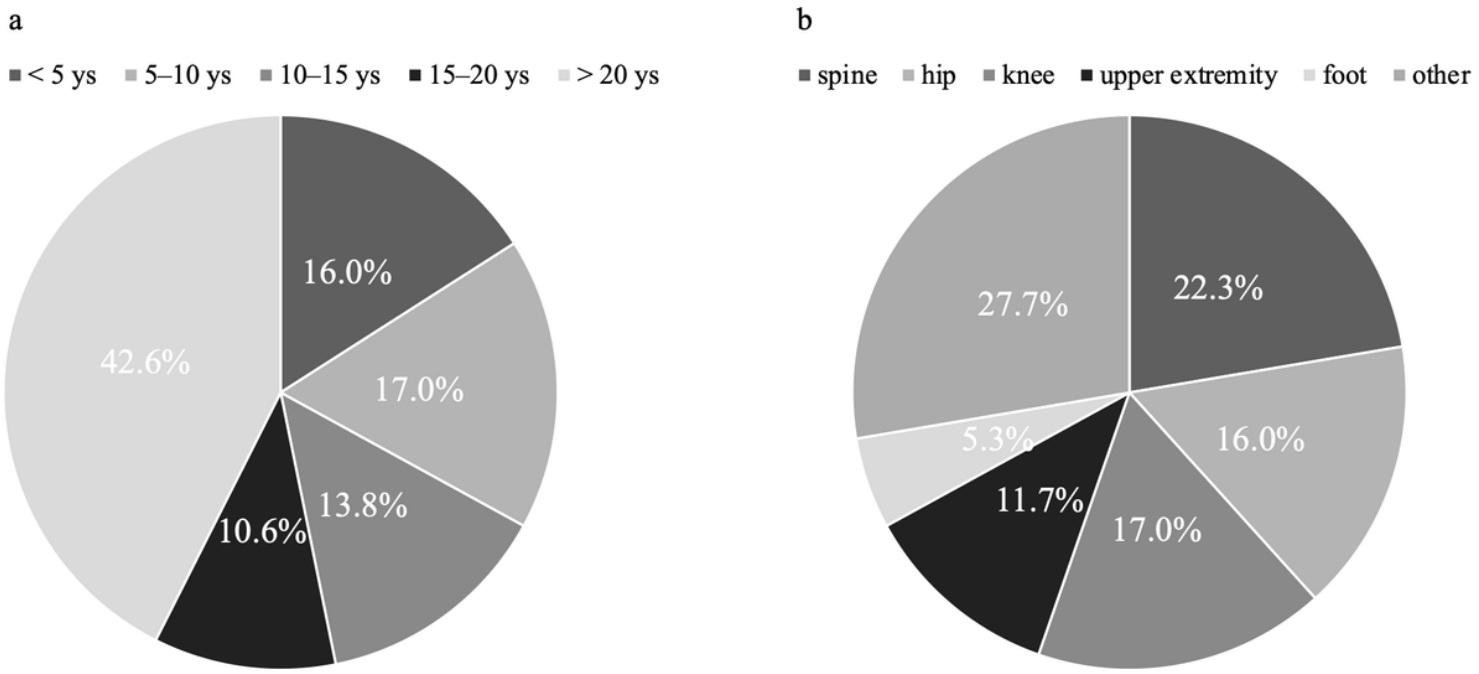

Figure 1

Experience and specialty areas of the orthopedic surgeon.

(a) The experience of the orthopedic surgeon (n=94). ys, years. (b) Specialty area of the orthopedic surgeon.

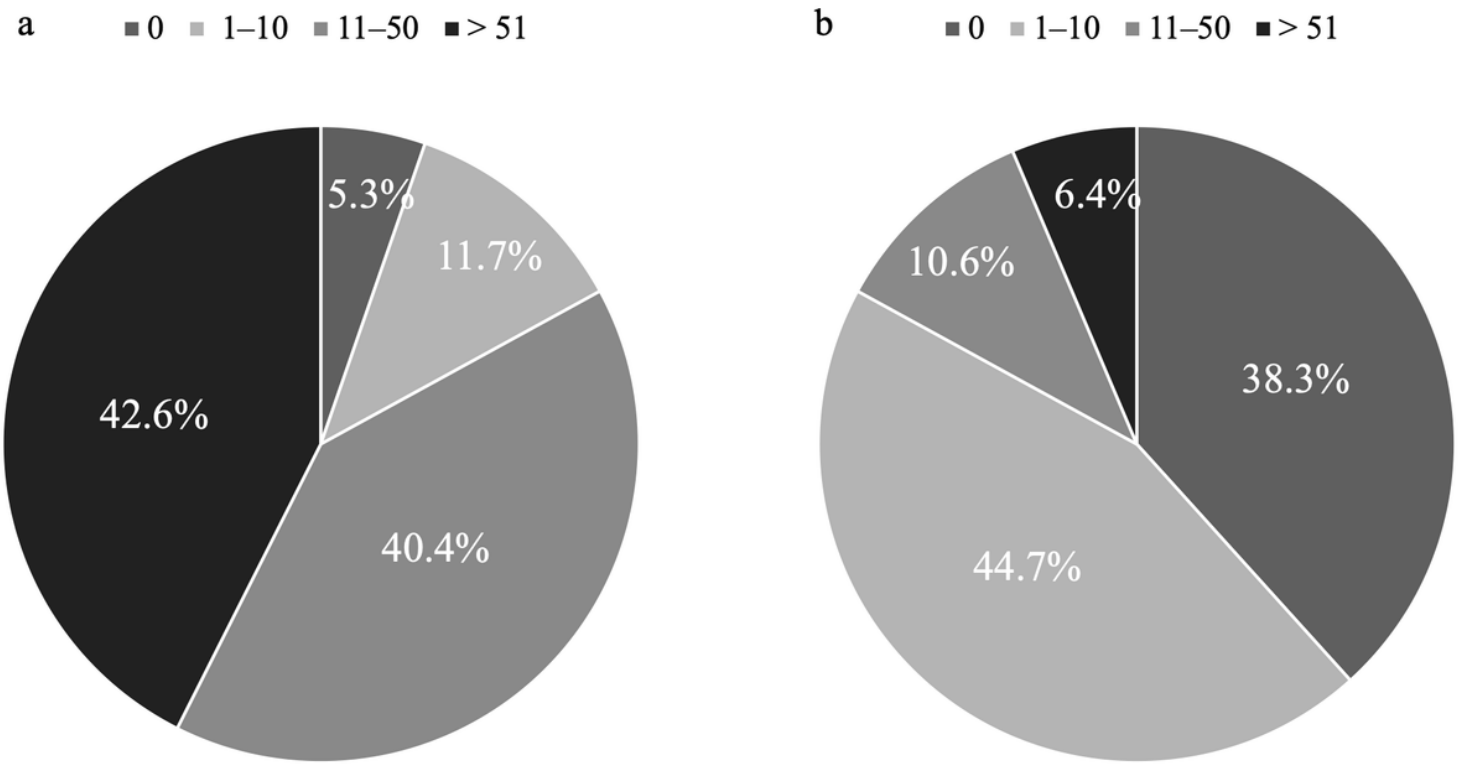

Figure 2

The percentage of cases of BHA and cemented stems.

(a) Cases of bipolar hemiarthroplasty. (b) Cases of cemented stems in bipolar hemiarthroplasty.

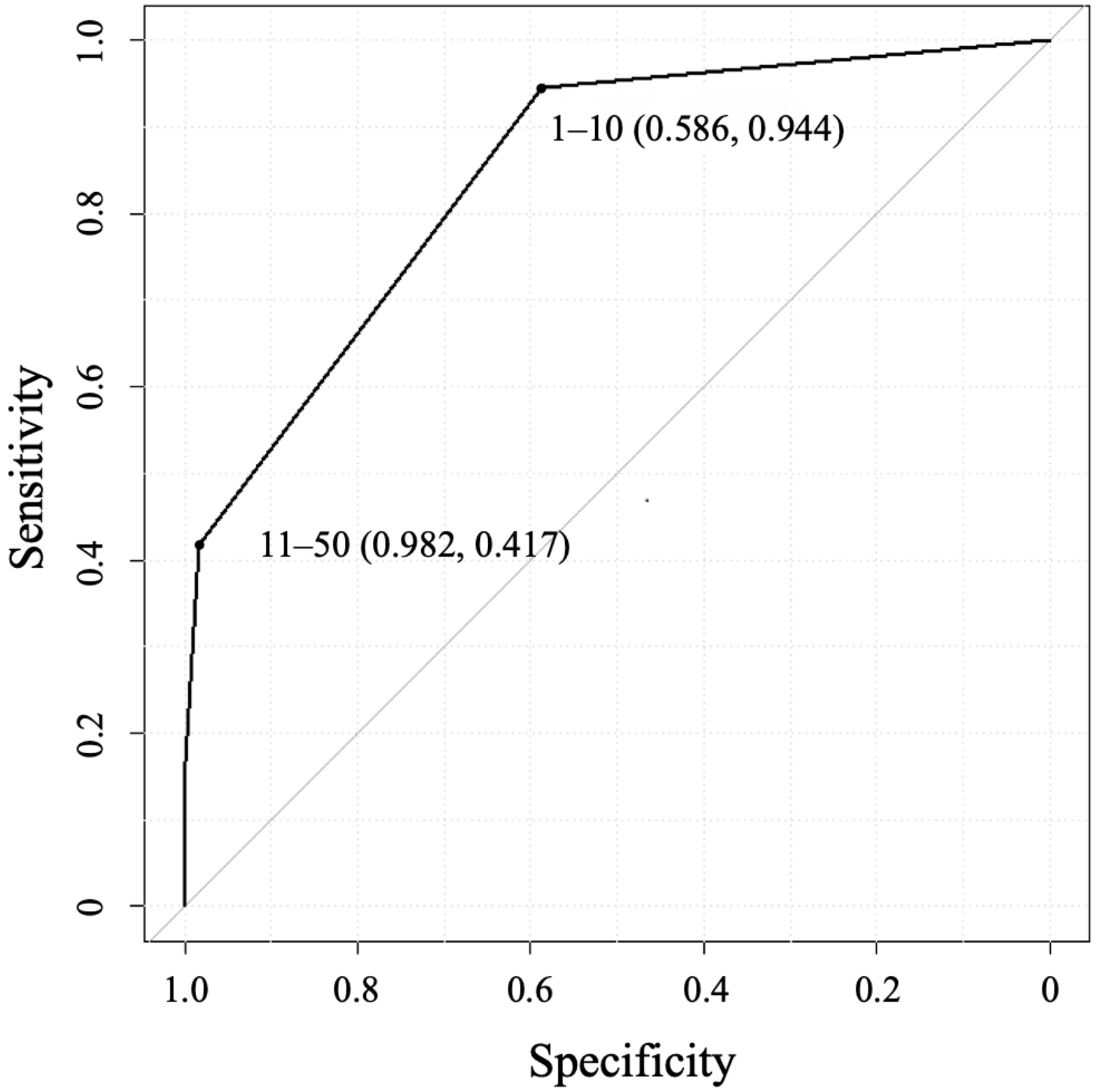

Figure 3

ROC curves for the ability to instruct cemented stems.

ROC curves for the ability to instruct cemented stems and the number of surgeries using cemented stems. The best cutoff value was 1–10 cases, with a sensitivity of 94.4% and a specificity of 58.6%. When the cutoff value was 11–50 cases, sensitivity was 41.7%, and specificity was 98.3%.

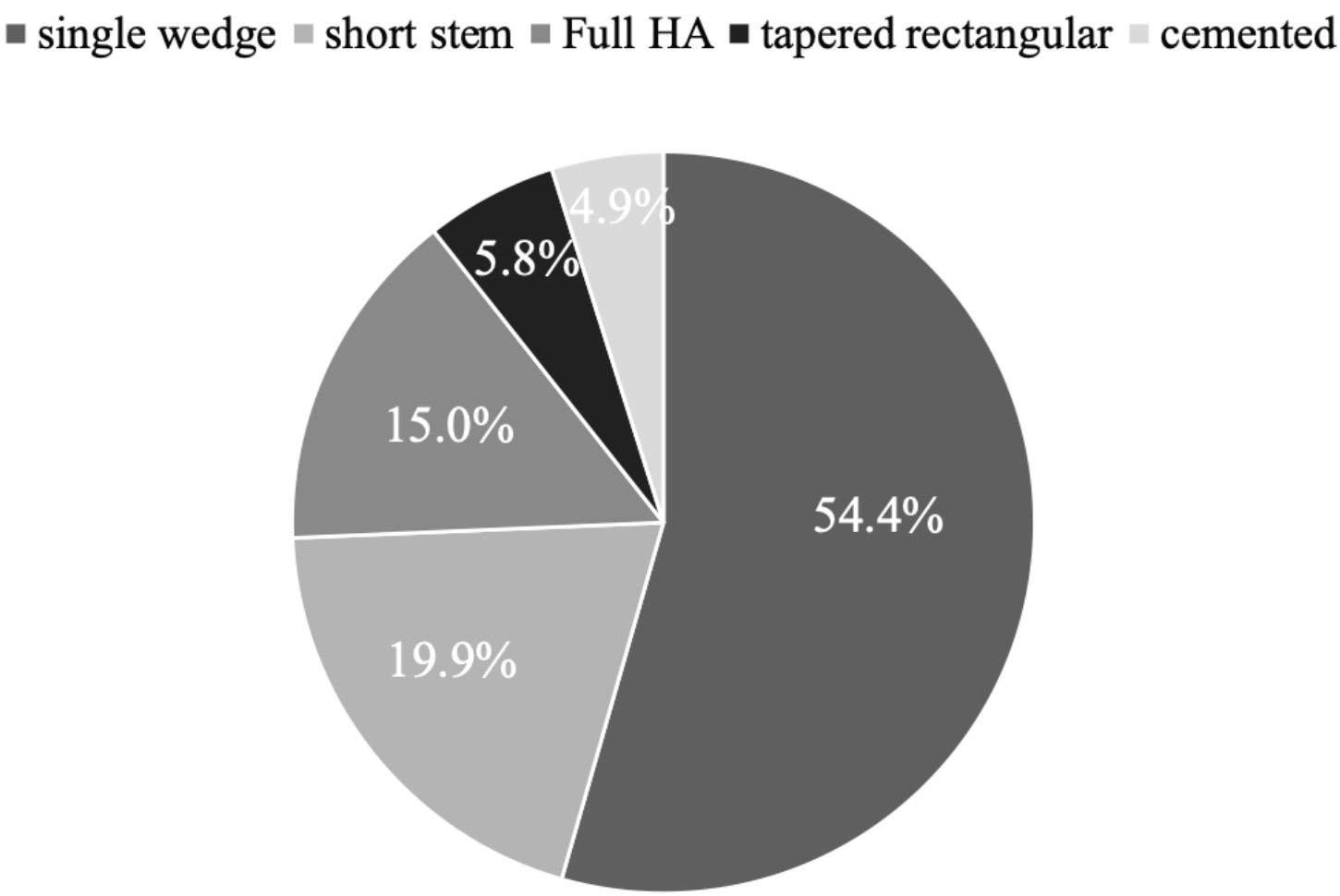

Figure 4

Survey of femoral stem used at facilities employing hip surgeons in 2021.

Single wedge stem was the most commonly used (54.4%, 123 cases), followed by short stems (19.9%, 45 cases), full HA (15%, 34 cases), tapered rectangle (5.8%, 13 cases), and cemented stems (4.9%, 11 cases).

Supplementary Files

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- supplementarymaterial.xlsx