

# Defining the Key Parts of a Procedure: Implications for Overlapping Surgery

Joseph Bernstein, MD  
 James J. Bernstein  
 Samir Mehta, MD  
 Eric L. Hume, MD  
 Mara L. Schenker, MD  
 Jaimo Ahn, MD, PhD

From the Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA (Dr. Joseph Bernstein, Dr. Mehta, Dr. Hume, and Dr. Ahn), Columbia College, Columbia University, New York, NY (Mr. James J. Bernstein), and the Department of Orthopaedic Surgery, Emory University, Atlanta, GA (Dr. Schenker).

Correspondence to Dr. Joseph Bernstein: Joseph.Bernstein@uphs.upenn.edu

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## Abstract

**Introduction:** The American College of Surgeons' *Statements on Principles* requires attending surgeons to be present for the "key parts" of surgical procedures, but the term is not defined. The research question addressed in this study is whether a functional definition of the critical or key steps of common orthopaedic surgical procedures can be reliably constructed. We used the examples of hip and knee arthroplasty because these procedures are highly structured and divisible into distinct subroutines.

**Methods:** We surveyed 100 experienced orthopaedic surgeons regarding whether particular steps in knee and hip arthroplasty procedures were considered "key." The patterns of individual surgeons' responses were compared among surgeons for overall reliability. The steps frequently cited as key were also identified.

**Results:** The agreement rates among surgeons for the definitions of the key parts of hip and knee arthroplasty were 3.2% and 8.6%, respectively. For both procedures, five steps were identified as key by >90% of the respondents.

**Discussion:** The agreement rate on what constitutes the key parts of hip and knee arthroplasty was poor, despite the fact that these are highly structured procedures. Accordingly, defining the key parts for a given procedure must rely on either the operating surgeon's discretion or a consensus definition. Imposing a single surgeon's standard on others is not the optimal approach because such a standard is likely to be idiosyncratic.

**Conclusion:** A consensus standard articulated by the orthopaedic surgery community may be the best means for identifying the key parts of orthopaedic surgical operations. The data presented here suggest a foundation upon which a consensus definition for the key parts of arthroplasty procedures may be built.

In October 2015, the *Boston Globe* published an investigation of the practice of concurrent surgery.<sup>1</sup> The newspaper reported allegations that orthopaedic surgeons at Massachusetts General Hospital were routinely operating on more than one patient concurrently and implied that this practice compromised

patient care. On the heels of this report, the American College of Surgeons (ACS) revised its *Statements on Principles* to declare that the coinciding occurrence of the "critical or key components of the procedures for which the primary attending surgeon is responsible"<sup>2</sup> on two different patients in two

different rooms is inappropriate. The American Academy of Orthopaedic Surgeons (AAOS) was “intimately involved with the development of the guidelines”<sup>3</sup> and formally endorsed them.

Critics of the ACS guidelines have responded that “leav[ing] the decision regarding what exactly constitutes ‘critical elements’ completely in the hands of the operating surgeon... is completely upside down.”<sup>4</sup> When the definition of the key portion of surgery is left to the attending surgeon, the argument goes, the system is open to abuse; surgeons could self-servingly define whatever parts of the case for which they were present to be the key components of the procedure and thereby undermine accountability. On the other hand, the ACS approach of allowing individual definition of the key portions, while imperfect, might be necessary if no agreement on the proper definition of key parts can be reached.

The research question addressed in this study is whether a functional definition of the critical or key parts of common orthopaedic surgical procedures can be reliably constructed. We used the examples of hip and knee arthroplasty for a few reasons. First, these procedures are highly structured and divisible into distinct subroutines. If a uniform verbal definition cannot be derived for these procedures, it is unlikely that such a definition can be derived for procedures with less clearly defined parts. Also, these arthro-

plasty procedures are common: >1,000,000 are performed annually in the United States, and the incidence is likely to increase.<sup>5</sup> Because these procedures are predictably structured, they are highly amenable to performance with overlap. Nevertheless, the aim of the study was not to identify definitive definitions of the key parts of these procedures, *per se*, but to use them as test cases to determine whether any consensus definition could be derived.

## Methods

The study was reviewed by the institutional review board and deemed exempt. We divided hip and knee arthroplasty procedures into 12 distinct steps using a modified Delphi approach. Four of the authors (S.M., E.L.H., M.L.S., J.A.) suggested steps that were melded by a fifth author (J.B.) into a unified delineation of steps that was then ratified by the other four authors.

For knee arthroplasty, the 12 steps were patient positioning; skin incision; arthrotomy; soft-tissue resection (eg, fat pad, menisci, anterior cruciate ligament); tibial bone cuts; femoral bone cuts; soft-tissue balancing; preparing the patella (assume resurfacing performed); assessing trial components for range of motion and stability; implantation of final components; assessment before closure; and closure. For hip arthroplasty, the steps comprised patient

positioning; skin incision; arthrotomy and capsulotomy; dislocation and femoral neck cut; acetabular soft-tissue resection (eg, labrum); acetabular reaming; inserting the acetabular component; femoral broaching and insertion of the femoral trial; assessing trial components for range of motion and stability; implantation of final components; assessment before closure; and closure.

A convenience sample of experienced orthopaedic surgeons was queried as to which of these steps should be considered key parts of the given procedure. The response group was assembled by posting a solicitation open to members of the AAOS and the American Association of Hip and Knee Surgeons, inviting them to opt into the study by sending their contact information. Those who responded were asked how many hip arthroplasty and knee arthroplasty procedures they had performed and whether they were certified by the American Board of Orthopaedic Surgery. Surgeons were also asked to provide basic demographic information: the number of years in practice after training; whether they worked with residents, fellows, or surgical assistants; and whether they belonged to specialty societies. De-identified data were aggregated from the first 100 board-certified respondents who had performed the particular procedure >100 times.

For each procedure, the 12 identified steps were presented, and the respondent was asked simply to

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**Table 1**  
**Memberships Reported by Respondents**

Organization	Knee Arthroplasty Group	Hip Arthroplasty Group
American Orthopaedic Association	29	31
American Orthopaedic Society for Sports Medicine	12	7
Orthopaedic Trauma Association	12	17
American Association of Hip and Knee Surgeons	58	58
Hip Society	4	4
Knee Society	7	8

**Table 2**  
**Number of Surgeons Citing Knee Arthroplasty Steps as “Key or Critical”<sup>a</sup>**

Step	Description	Number of Surgeons
1	Patient positioning	19
2	Skin incision	26
3	Arthrotomy	37
4	Soft-tissue resection	44
5	<b>Tibial bone cuts</b>	<b>92</b>
6	<b>Femoral bone cuts</b>	<b>93</b>
7	<b>Soft-tissue balancing</b>	<b>97</b>
8	Preparing patella (assume resurfacing performed)	88
9	<b>Assessing trial components for range of motion and stability</b>	<b>98</b>
10	<b>Implantation of final components</b>	<b>90</b>
11	Assessment before closure	80
12	Closure	28

<sup>a</sup> Respondent group consisted of 100 surgeons. Bold indicates steps designated as key by ≥90% of respondents.

indicate whether that step should be considered “key.” Because each of the 12 steps could individually be designated “key” or “not key,” the pattern of responses was coded as a 12-bit string of ones and zeros. For example, if a respondent indicated that only “closure” is key, the response would be coded as 000000000001. If the respondent indicated that “assessment before closure” and “closure” were the only two key steps, the response would be coded as 000000000011. These bit strings, representing the respon-

dent’s overall definition of the key parts of the case, were then compared between all pairs of surgeons to calculate reproducibility rates for every surgeon.

We further tabulated the number of respondents voting “yes” for each of the steps, to determine the consensus, if any, on whether a given step should be designated as key. The adjustment factor needed to account for chance agreement,  $0.24 \times 10^{-4}$ , was deemed trivial and was accordingly omitted. A sample size of 96 respondents was calculated as nec-

essary to provide a 10% margin of error with 95% confidence. We sought 100 respondents to facilitate conversion of raw response rates into percentages.

**Results**

**Total Knee Arthroplasty**

The mean number of years of experience for the 87 respondents who provided this information was 21.1 years. A total of 65 respondents reported working routinely with residents or fellows. Of the remaining 35 respondents, 28 reported working with a surgical assistant. The organizations to which the respondents belonged are shown in Table 1.

The mean number of steps designated as key was 7.9. Responses ranged from 1 step—namely, “Implantation of final components,” as defined by 1 surgeon—to all 12 steps, a response chosen by 13 surgeons. The reproducibility (unadjusted kappa) of the surgeons’ overall definition of the key parts of knee arthroplasty was 8.6%.

Among the 100 respondents, the numbers of respondents who deemed a given step to be key are shown in Table 2. As shown, five steps were designated as key by ≥90% of respondents. If the definition of the key steps of total knee arthroplasty were limited to exactly these five steps, 82 of the 100 respondents would be in compliance. The modal response, chosen by 23 surgeons, was to consider the seven steps from “tibial bone cuts” through “assessment before closure” to be key.

**Total Hip Arthroplasty**

The mean number of years of experience among the 89 respondents who provided this information was 21.0 years. A total of 66 respondents reported working routinely with residents or fellows. Of the remaining 34

respondents, 26 reported working with a surgical assistant. The organizations to which the respondents belong are shown in Table 1.

The mean number of steps designated as key was 8.1. Responses ranged from 2 steps, designated by 3 surgeons—although each of them chose a different pair of steps—to all 12 steps, a response chosen by 14 surgeons. Designating all 12 steps as key was the modal response. The reproducibility (unadjusted kappa) of the surgeons' overall definition of the key parts of hip arthroplasty was 3.2%.

The numbers of respondents who deemed a given step to be key are shown in Table 3. As shown, five steps were designated as key by  $\geq 90\%$  of respondents. If the definition of the key steps of total hip arthroplasty were limited to these five steps, 81 of the 100 respondents would be in compliance.

## Discussion

Overlapping surgery, as Kent et al<sup>6</sup> reported, “is a long-standing practice in academic medical centers.” Other authors have noted that “staggered procedures [have] been a common and accepted practice in high-complexity surgery for many years”<sup>7</sup> and that this practice can be “used to maximize the number of patients able to access [expert] surgeons and their surgical teams.”<sup>8</sup> Nonetheless, Mello and Livingston<sup>9</sup> report that “there is limited research on whether overlapping scheduling of operations is associated with worse surgical outcomes, but...overlapping operations clearly pose risks.” Accordingly, the practice has come under close public scrutiny. Meanwhile, the ACS has announced that overlapping surgery is acceptable, provided that the procedures are sufficiently spaced in time such that the “critical or key components of the procedures” are not taking place at the same instant.<sup>2</sup>

**Table 3**

**Number of Surgeons Citing Hip Arthroplasty Steps as “Key or Critical”<sup>a</sup>**

Step	Description	Number of Surgeons
1	Patient positioning	50
2	Skin incision	36
3	Arthrotomy and capsulotomy	45
4	Dislocation and femoral neck cut	61
5	Acetabular soft-tissue resection (eg, labrum)	43
<b>6</b>	<b>Acetabular reaming</b>	<b>91</b>
<b>7</b>	<b>Inserting acetabular component</b>	<b>97</b>
<b>8</b>	<b>Femoral broaching and insertion of femoral trial</b>	<b>91</b>
<b>9</b>	<b>Assessing trial components for range of motion and stability</b>	<b>95</b>
<b>10</b>	<b>Implantation of final components</b>	<b>93</b>
11	Assessment before closure	82
12	Closure	28

<sup>a</sup> Respondent group consisted of 100 surgeons. Bold indicates steps designated as key by  $\geq 90\%$  of respondents.

The ACS has issued no guidelines about what parts of surgery are key. Likewise, the AAOS has issued no specifications regarding the key parts of orthopaedic procedures. Rather, the designation of key parts of a procedure was left to the judgment of the individual surgeon.

In this study, using hip and knee arthroplasty as the test cases, we assessed whether the designation of the key parts of surgical procedures can be made consistently by a group of experienced orthopaedic surgeons. We found that it cannot: the mean agreement rate for the overall definition was  $<10\%$ , with no single pattern garnering  $>25\%$  of the vote for either procedure. This finding is critical because Medicare rules state that “in order to bill Medicare for two overlapping surgeries, the teaching surgeon must be present during the critical or key portions of both operations.”<sup>10</sup> Thus, ambiguity or disagreement about the definition of the key parts of surgery can expose a surgeon to financial penalties or even criminal charges.

Because the definition of the key parts of surgery involves Medicare billing, the question of overlapping surgery was addressed by the US Senate Finance Committee. In December 2016, this committee issued a report titled *Concurrent and Overlapping Surgeries: Additional Measures Warranted*.<sup>11</sup> One of the measures encouraged by the committee was that hospitals “formally identify the critical portions of particular procedures.”<sup>11</sup>

Our results dovetail with the committee's recommendations. Imposing a single surgeon's standard on others is not the optimal approach because such a standard is likely to be idiosyncratic. If a generalized definition of the key parts of surgery must be created, then a group consensus standard, as suggested by the Senate committee, may be best. The current study demonstrates the potential for building such a consensus. We found five steps in each procedure that garnered  $\geq 90\%$  endorsement as key. For both procedures, we identified a possible consensus definition of the key parts



that would keep >80% of the group in compliance.

## Limitations

This study's methods have limitations, some of which are inherent in any attempt to create a generalizable semantic rubric defining "key parts." These limitations can be categorized as those attributable to features of the response group, those inherent in the survey instrument, and those based on our mode of analysis. The limitations in each of these three categories are described at length to clarify what can be claimed on the basis of this study and what cannot.

### Response Group Limitations

Our data were produced by a group of board-certified orthopaedic surgeons who have performed the procedures in question >100 times. Although this eligibility criterion certainly speaks to the participants' familiarity with the procedures, the group may not be representative of orthopaedic surgeons at large. We found that participants who practiced in an academic setting were overrepresented. In addition, the group was assembled as a convenience sample that participants joined, presumably, out of interest. Therefore, avid attentiveness to the topic may have skewed the composition of the group.

However valid these criticisms may be, they would carry more weight if we either found a high rate of agreement or asserted that the group's overall response represented a definitive definition of the key parts of these procedures. We did neither. Instead, we found that the responses were highly disparate. The use of this nonrepresentative population is likely not to undermine this conclusion, but rather to strengthen it.

### Survey Instrument Limitations

The survey instrument was based on an a priori definition of the "parts" of

total joint arthroplasty, and our choices may be open to criticism. We may have omitted steps that another survey designer might have chosen to include; we may have split into two steps those that others might have combined; and we may have included some steps that others would not recognize as worthy of designation. Although our choices retain reasonable face validity, supported by our use of a Delphi-like process among the authors, a more robust approach may have been to first collect responses on what the steps are before asking whether they are key.

The decision to split the procedures into 12 steps can be criticized.<sup>12</sup> If we had chosen to represent the procedures with fewer steps, higher agreement would have been more likely. After all, if a procedure had only two steps, only four votes would be possible, and by definition at least half of the group would be in compliance with the group's definition. Yet if too few steps are listed, the results can be misleading because the original question remains present, just buried one layer deeper. Consider the extreme example in which a procedure has only one step, namely, "perform joint replacement." In that scenario, the agreement rate would be 100%, but the question becomes "For what fraction of a step must the attending surgeon be present to get credit for that step?"

The listing of the steps also did not account for the fact that some steps include an opportunity for correcting mistakes made in a prior step. For instance, insufficient resection of the femur or tibia during knee arthroplasty may be detected during the soft-tissue balancing step, with the error corrected then. Because of the possibility for later remedy, a particular step may have been designated as not key by some respondents, despite the step's importance to the overall outcome.

Finally, the definition of the steps did not stipulate who remains in the room when the attending surgeon is absent. This consideration is critical: in the minds of some respondents, the presence of an attending surgeon working with junior residents might be needed for the entire procedure, whereas a chief resident (or an experienced surgical assistant) can be granted more independence.

These criticisms are all valid but would apply to any attempt to derive a verbal definition, not just our approach. More flexible survey methods that address any of these limitations, moreover, would likely increase the variability of the responses.

### Analysis Limitations

Our analysis of the responses, in which respondents voted yes or no for each of the designated parts, has limitations. A more nuanced method would ask respondents to rate the given step's degree of essentiality (perhaps on a scale from 1 to 10) and ask how certain (or vehement) the respondent was. This method would give a seemingly deeper understanding of the group's thinking but would not necessarily reveal the groups' "true" belief, just as different winners may emerge from an election depending on the type of voting system used.<sup>13</sup> More to the point, the ACS considers the term "key parts" to be binary,<sup>2</sup> and our methods are consistent with that approach.

We also did not perform any intra-surgeon reproducibility tests, that is, presenting the survey to the group twice to see whether respondents agree with themselves over time. This omission would be more salient if we attempted to assert that our particular findings provided a definitive delineation of the key steps. On the other hand, showing poor intra-surgeon reliability would be even further evidence that an external

semantic definition would be inadequate, which is our conclusion here.

Our findings are limited to well-scripted procedures, such as hip and knee arthroplasty. Although it is reasonable to criticize our parsing of the procedures into 12 steps, key or otherwise, it would be even easier to criticize such a parsing of less algorithmic procedures, especially in instances in which the patient's anatomy is distorted by trauma or disease. Still, our argument remains that if even these well-scripted procedures cannot produce consistent definitions of the key parts, other procedures are likely to fare even worse. That is, our results for well-scripted procedures are logically an upper bound on reliability for procedures overall.

## Conclusion

Overlapping surgery is a contentious topic and is likely to become even more so. Many practical, moral, financial, and legal issues must be unpacked,<sup>6,14,15</sup> and we address none of them here. Rather, we ask a simple question: if the surgeon is required to be present for the key parts of the procedure, can we reach agreement over what exactly constitutes those parts? Without such an agreement, either the individual surgeon's definition must be used (as the ACS guidelines suggest) or an external definition would be imposed. One inference from our work is that it would be unfair to impose an individual surgeon's definition on a colleague's work because there is intra-surgeon vari-

ability in how key parts are defined. Nonetheless, at least in the case of highly structured arthroplasty procedures, there may be a core of agreed-upon steps that can serve as the basis of a consensus definition articulated by the orthopaedic surgery community. This consensus is needed; without a valid definition of what constitutes the "key parts" of given surgical procedures, a standard that requires attending surgeons to be present for these parts lacks sufficient meaning to be effective.

## References

*Evidence-based Medicine:* Levels of evidence are described in the table of contents. In this article, reference 8 is a level IV study. References 5-7, 9, 14, and 15 are level V expert opinion.

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