

# Concurrent and overlapping surgery: perspectives from surgeons on spinal posterior instrumented fusion for adolescent idiopathic scoliosis

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## Abstract

**Purpose** The purpose of this study was to determine perspectives of surgeons regarding simultaneous surgery in patients undergoing posterior spine instrumentation and fusion (PSIF) for adolescent idiopathic scoliosis (AIS).

**Methods** A survey was administered to orthopaedic trainees and faculty regarding simultaneous surgery for primary PSIF for AIS. A five-point Likert scale (1: 'Strongly Disagree' to 5: 'Strongly Agree') was used to assess agreement with statements about simultaneous surgery. We divided simultaneous surgery into concurrent, when critical portions of operations occur at the same time, and overlapping, when noncritical portions occur at the same time.

**Results** The 72 respondents (78.3% of 92 surveyed) disagreed with concurrent surgery for 'one of my patients' (response mean 1.76 (SD 1.03)) but were more accepting of overlapping surgery (mean 3.94 (SD 0.99);  $p < 0.0001$ ). The rating difference between concurrent and overlapping surgery was smaller for paediatric and spine surgeons (-1.25) than for residents or those who did not identify a subspecialty (-2.17;  $p = 0.0246$ ) or other subspecialty surgeons (-2.57;  $p = 0.0026$ ). Respondents were more likely to agree with explicit informed consent for concurrent surgery compared with overlapping (mean 4.32 (SD 0.91) versus 3.44 (SD 1.14);  $p < 0.001$ ).

**Conclusion** Orthopaedic surgeons disagreed with concurrent but were more accepting of overlapping surgery and anaesthesia for PSIF for AIS. Respondents were in greater agreement that patients should be explicitly informed of concurrence than of overlap. The surgical community's evidence and position regarding simultaneous surgery, in particular overlapping, must be more effectively presented to the public in order to bridge the gap in perspectives.

**Level of Evidence:** IV

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**Keywords:** overlapping; concurrent; simultaneous surgery; adolescent idiopathic scoliosis

## Introduction

Simultaneous surgery is under scrutiny. In 2015, a *Boston Globe* article shone a spotlight on a complication that occurred during concurrent spine operations.<sup>1</sup> In the following year, the American College of Surgeons (ACS) established guidelines stipulating that overlapping surgery (simultaneity during 'noncritical' portions of an operation) was acceptable while concurrent surgery (simultaneity during 'critical' portions of an operation) was inappropriate.<sup>2</sup>

Recent studies have attempted to evaluate outcomes of, as well as patient perspectives regarding, simultaneous surgery. Glauser et al<sup>3</sup> found no short-term adverse outcomes after overlapping surgery at a large academic medical centre. On the other hand, Bryant et al<sup>4</sup> showed that parents of patients undergoing posterior instrumentation and fusion (PSIF) for adolescent idiopathic scoliosis (AIS) were not agreeable to simultaneous scheduling of any type, even when presented with research demonstrating the safety of simultaneous surgery. The discrepancy between the medical literature and patient perspective on simultaneous surgery highlights a need to better align patient and surgeon expectations.

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While patient perspectives on simultaneous surgery and anaesthesia, as well as the participation of trainees, have been examined, there remain limited data regarding surgeon perspectives on this topic. We surveyed surgeons on simultaneous surgery and anaesthesia for their patients, as well as for themselves/their family member. We compared the results with previous findings on parents of patients undergoing PSIF for AIS. Our objective was to elucidate an essential component of the simultaneous surgery debate, in order to advance the national conversation between patients and surgeons.

### Materials and methods

We administered a survey to resident and fellowship-trained faculty orthopaedic surgeons at an academic medical centre regarding simultaneous primary PSIF for AIS. The study was approved by the institutional review board.

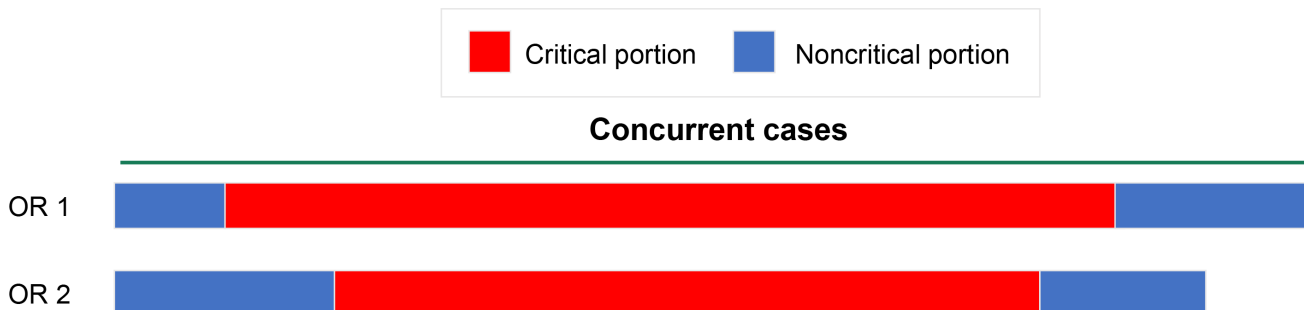
We defined simultaneous surgery as concurrent, when critical portions of operations occur at the same time, and overlapping, when noncritical portions occur at the same time<sup>4</sup> (Fig. 1). What constitutes a critical portion of a case is at the surgeon's discretion.<sup>2</sup> Overlapping surgery was

defined as when two noncritical portions of a case occur simultaneously, namely at the beginning (e.g. spine exposure) and at the end (e.g. wound closure) (Fig. 2).<sup>4</sup> Separate questions applied to the faculty surgeon, to surgical trainees, and to the anaesthesiologist during simultaneous operations (Table 1).

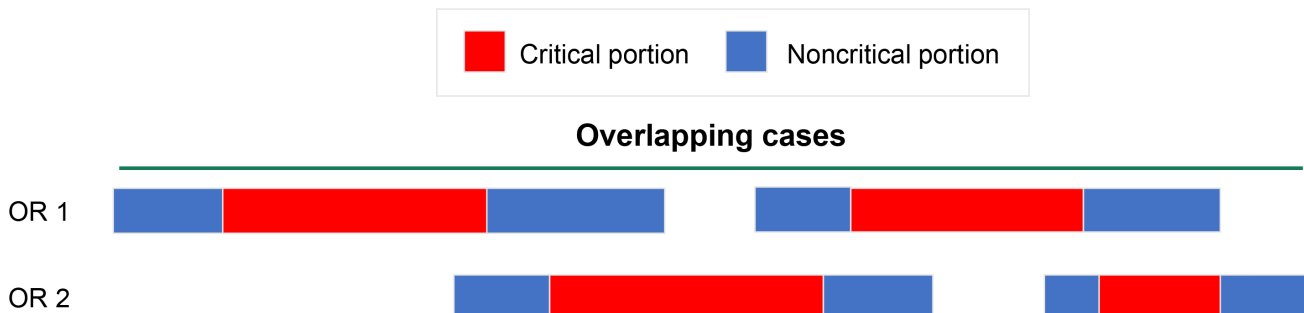
The survey was developed in Qualtrics (Qualtrics<sup>SM</sup>, Provo, Utah) and administered anonymously. Surgeon characteristics included level of training and type of subspecialty. In total, 13 questions queried agreement/acceptability of concurrent or overlapping procedures. Questions were graded on a Likert agreement scale from 1 to 5, with 1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly Agree. Eight questions were related to the procedure itself (Table 1) and five questions were related to obtaining informed consent (Table 2).

#### Statistical analysis

Descriptive statistics including mean, SD, variance, range and 95% confidence intervals (CI) are reported. For within subject comparisons, we used the Wilcoxon signed-rank test, and for between-subject comparisons, we used the Wilcoxon rank-sum test. Statistical significance was set at



**Fig. 1** Concurrent cases. During concurrent operations, the attending surgeon or anaesthesiologist may need to leave the room to care for another patient or move back and forth between two operating rooms (ORs) for cases on two different patients at the same time. Critical portions of the case may coincide with critical portions of the other patient's case.



**Fig. 2** Overlapping cases. When operations on two different patients are occurring in two different operating rooms (ORs) at the same time, however, during overlapping operations, cases are staggered such that critical portions of the case do not overlap. This allows the surgeon or anaesthesiologist to be present during critical portions of the case and leave the room during noncritical portions.

p < 0.05. Statistical analysis was performed using STATA v15 (StataCorp, College Station, Texas).

## Results

A total of 72/92 (78.3%) possible participants completed the survey (41 residents; 29 faculty surgeons; two did not

identify level of training). Of the 29 attending surgeons, 12 were paediatric or spine surgeons (n = 12). Two participants who did not identify a subspecialty were grouped with junior residents who had no declared subspecialty interest.

**Table 1** Survey questions related to the operation of posterior spinal fusion and instrumentation for adolescent idiopathic scoliosis

Question #	Field
1	It would be acceptable to me to have <u>one of my patients'</u> operations scheduled as a <b>concurrent surgery</b> with another one of my patients' operations.
2	It would be acceptable to me to have <u>one of my patients'</u> operations scheduled as an <b>overlapping surgery</b> with another one of my patients' operations.
3	It would be acceptable to me to have this surgery performed on <u>me/my family member</u> as a <b>concurrent surgery</b> with another patient.
4	It would be acceptable to me to have this surgery performed on <u>me/my family member</u> as an <b>overlapping surgery</b> with another patient.
5	It would be acceptable to me if the <u>anaesthesiologist</u> responsible for this operation is scheduled for a <b>concurrent</b> operation.
6	It would be acceptable to me if the <u>anaesthesiologist</u> responsible for this operation is scheduled for an <b>overlapping</b> operation.
7	It would be acceptable to me to have a senior resident (4 <sup>th</sup> or 5 <sup>th</sup> year) trainee perform the <b>noncritical</b> part of the operation <u>without direct attending supervision</u> .
8	It would be acceptable to me to have a senior resident (4 <sup>th</sup> or 5 <sup>th</sup> year) trainee perform the <b>critical</b> part of the operation <u>with direct attending supervision</u> .

**Table 2** Survey questions related to the process of obtaining informed consent for the operation of posterior spinal fusion and instrumentation for adolescent idiopathic scoliosis

Question #	Field
9	The patient should be informed if this case is scheduled <b>concurrently</b> with another operation by the same <u>surgeon</u> .
10	The patient should be informed if this case is scheduled <b>overlapping</b> with another operation by the same <u>surgeon</u> .
11	The patient should be informed if the <u>anaesthesiologist</u> responsible for this operation is scheduled for a <b>concurrent</b> operation.
12	The patient should be informed if the <u>anaesthesiologist</u> responsible for this operation is scheduled for an <b>overlapping</b> operation.
13	The patient should be informed if a resident trainee will be participating in this operation.

### Concurrent (critical) versus overlapping (noncritical) surgery: surgeons and anaesthesiologists

The respondents did not find concurrent surgery acceptable (mean Likert rating: 1.76 (SD 1.0)). By contrast, they were more accepting of overlapping surgery (3.94 (SD 0.99)). Of the 72 respondents, 65 (90.3%) rated concurrent surgery as less acceptable than overlapping surgery, six (8.3%) rated them the same and one (1.4%) rated concurrent surgery as more acceptable. The mean difference in agreement (concurrent – overlapping) was -2.18 (95% CI -2.47 to -1.90; p < 0.0001). With regards to surgeon perspectives on simultaneous anaesthesia, mean concurrence (2.49 (SD 1.27)) was also less acceptable than overlapping (3.72 (SD 1.09)), with mean difference -1.23 (-1.53 to -0.94; p < 0.0001). The agreement gap between concurrent and overlapping surgery was greater than between concurrent and overlapping anaesthesia, with mean difference (surgeons – anaesthesiologists) -0.94 (-1.23 to -0.66; p < 0.0001) (Table 3).

### 'My patient' versus 'me/my family member'

The mean rating for concurrent surgery was lower for 'me/my family member' (1.67 (SD 0.96)) compared with 'one of my patients' (1.76 (SD 1.03); p = 0.038). However, the majority of respondents (61/72, 84.7%) chose the same rating for both family member and patient; nine (12.5%) chose a lower rating for a family member; and two (2.8%) chose a higher rating. For overlapping surgery, there also was a difference (-0.26; p = 0.0007) in ratings for 'me/my family member' (3.68 (SD 1.12)) versus for 'one of my patients' (3.94 (SD 0.99)). In all, 56 respondents rated the patient equal to the family member; 15 rated overlapping lower for a family member and one rated it higher (Table 3).

**Table 3** Acceptability of simultaneous surgery for surgeons and anaesthesiologists with regards to posterior instrumented fusion for adolescent idiopathic scoliosis.

Acceptability	Concurrent			Overlapping			Difference	95% confidence interval	p-value
	N	Mean (SD)	p-value	Mean (SD)	p-value				
Surgeon ('on one of my patients')	72	1.76 (1.03)	-	3.94 (0.99)	-	-2.18	-2.47 to -1.9	<0.0001	
Anaesthesiologist ('on one of my patients')	72	2.49 (1.27)	-	3.72 (1.09)	-	-1.23	-1.53 to -0.94	<0.0001	
Difference vs surgeon ('On one of my patients')		-0.73	< 0.0001	0.22	0.022	-0.94	-1.23 to -0.66	<0.0001	
Surgeon ('me/my family member')	72	1.67 (0.96)	-	3.68 (1.12)	-	-2.01	-2.32 to -1.71	<0.0001	
Difference vs surgeon ('on one of my patients')		-0.10	0.038	-0.26	0.0007	0.17	-0.01 to 0.34	0.0661	

For within subject comparisons, Wilcoxon signed-rank test was used, and for between-subject comparisons, Wilcoxon rank-sum test was used. Bold values indicate statistical significance (p < 0.05).

*Level of training or subspecialty*

There was no significant difference in the way residents rated concurrent or overlapping surgery compared with faculty surgeons. There was no significant difference when grouping junior residents (R1, R2, R3) compared with senior residents (R4, R5) compared with faculty surgeons (Table 4).

Because the case discussed was paediatric spine, we separately analyzed paediatric surgeons and spine surgeons (n = 12). Paediatric and spine surgeons demonstrated no difference regarding concurrent or overlapping surgery compared with those without identified specialty training or compared with those with an alternative subspecialty. However, the magnitude of difference between opinions of concurrent and overlapping surgeries was smaller for paediatric and spine surgeons (-1.25 (-2.07 to -0.43)) compared with those without an identified specialty (-2.17 (-2.62 to -1.72; p = 0.0246)) and compared with other subspecialty surgeons (-2.57 (-2.94 to -2.19; p = 0.0026)) (Table 4).

*Informed consent*

There was strong agreement that patients should be informed if a case is scheduled concurrently (4.32

(SD 0.91)). While there was agreement with informing patients about overlapping surgery (3.44 (SD 1.14)), this was less strong than with concurrent (difference concurrent – overlapping: 0.89 (0.59 to 1.19; p < 0.001)). Respondents felt a patient should be informed if the anaesthesiologist was scheduled concurrently (4.04 (SD 1.09)), and again this was significantly higher than if the anaesthesiologist was scheduled overlapping (3.45 (SD 1.17)) (difference 0.59 (0.33 to 0.86; p < 0.001)). There was strong agreement that patients should be informed when a resident was to participate in any operation (3.97 (SD 0.94)) (Table 5).

*Resident involvement*

Respondents agreed that it was acceptable for residents to perform noncritical portions of a case without supervision (3.76 (SD 0.93)). They were less agreeable that residents should perform a critical part of a case, even with supervision (3.12 (SD 1.45)); the variance with regards to residents performing noncritical portions unsupervised was 0.87 compared with a larger variance for performing the critical portion supervised of 2.11. Comparing these standard deviations/variances using a variance ratio test, the difference was significant (p < 0.001).

**Table 4** Acceptability of simultaneous surgery for surgeons by training level and by subspecialty with regards to posterior instrumented fusion for adolescent idiopathic scoliosis.

Acceptability	Concurrent			Overlapping			Difference	95% confidence interval	p-value
	N	Mean (SD)	p-value	Mean (SD)	p-value				
Attending surgeon	29	1.62 (1.01)	-	3.76 (1.15)	-	-2.14	-2.66 to -1.61	< 0.0001	
All residents	41	1.78 (0.99)	-	4.05 (0.86)	-	-2.27	-2.61 to -1.92	< 0.0001	
Difference vs attending		-0.16	0.44	-0.29	0.35	0.13	-0.46 to 0.72	0.66	
Junior residents	28	1.89 (0.99)	-	4.18 (0.82)	-	-2.29	-2.76 to -1.82	< 0.0001	
Difference vs attending		-0.27	0.61	-0.42	0.60	0.15	-0.54 to 0.84	0.82	
Senior residents	13	1.54 (0.97)	-	3.77 (0.93)	-	-2.23	-2.73 to -1.73	0.0012	
Difference vs attending		0.08	0.73	-0.01	0.80	0.09	-0.75 to 0.93	0.93	
Paediatrics and spine	12	2.00 (1.21)	-	3.25 (1.6)	-	-1.25	-2.07 to -0.43	0.0061	
Residents/no specialty	30	2.00 (1.05)	-	4.17 (0.83)	-	-2.17	-2.62 to -1.72	< 0.0001	
Difference vs paediatrics and spine		0.00	0.84	-0.92	0.12	0.92	0.068 to 1.77	0.025	
Other specialties	30	1.43 (0.86)	-	4.00 (0.69)	-	-2.57	-2.94 to -2.19	< 0.0001	
Difference vs paediatrics and spine		0.57	0.12	-0.75	0.26	1.32	0.56 to 2.07	0.0026	

For within subject comparisons, Wilcoxon signed-rank test was used, and for between-subject comparisons, Wilcoxon rank-sum test was used. Bold values indicate statistical significance (p < 0.05).

**Table 5** Agreeability ratings on whether simultaneous surgery should be included as a part of the informed consent process for the surgeon and the anaesthesiologist.

	Concurrent			Overlapping			Difference	95% confidence interval	p-value
	N	Mean (SD)	p-value	Mean (SD)	p-value				
Surgeon	71	4.32 (0.91)	-	3.44 (1.14)	-	0.89	0.59 to 1.19	< 0.0001	
Anaesthesiologist	71	4.04 (1.09)	-	3.45 (1.17)	-	0.59	0.33 to 0.86	< 0.0001	
Differences		0.28	0.0007	-0.01	0.82	0.30	0.09 to 0.50	0.0031	

For within subject comparisons, Wilcoxon signed-rank test was used, and for between-subject comparisons, Wilcoxon rank-sum test was used. Bold values indicate statistical significance (p < 0.05).

## Discussion

Support for simultaneous surgery includes that it increases supply to meet demand for patients, and that it increases efficiency for hospitals and surgeons. Zachwieja et al<sup>5</sup> found that there was an increased profit margin of \$1215 per procedure for primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) when cases overlapped by at least 30 minutes. This conflict of interest, in addition to the theoretical risk of adverse events, has called simultaneous surgery into question. For example, trauma literature has shown that patients are concerned about the absence of the attending physician in the operating room, risk of error by a surgical trainee and risk of a missed step in the surgical procedure in the setting of simultaneous surgery.<sup>6</sup>

Parents of children undergoing PSIF for AIS have been previously surveyed.<sup>4</sup> AIS patients are a relatively homogeneous cohort. PSIF is a high stakes procedure, sharpening patient and surgeon focus. Parents are likely to be more vigilant for their children than for themselves. In the present study, we examine the other side of the simultaneous surgery coin, using the same scenario of PSIF for AIS for consistency.

Orthopaedic surgeons disagreed with concurrent surgery and were more supportive of overlapping surgery. They agreed with informing patients of both concurrent and overlapping surgery. These findings mirror ACS guidelines that state concurrent surgery is inappropriate while overlapping surgery is acceptable with proper informed consent.<sup>2</sup> By contrast, we previously found that parents disagreed with both concurrent and overlapping surgery for their children.<sup>4</sup>

The difference of opinion held by surgeons regarding simultaneous surgery compared with their patients may be based on literature showing no clinically significant difference in outcomes between overlapping and non-overlapping surgery. In a study of 18 316 elective orthopaedic procedures (3395 overlapping), Glauser et al<sup>3</sup> found no difference in reoperation, readmission or emergency room visit rates at 30 or 90 days compared with matched controls. In a cohort of 4786 primary THA/TKA patients undergoing simultaneous surgeries of at least 30 minutes, Zachwieja et al<sup>5</sup> found no difference in readmission rate, length of stay or rates of discharge. Similarly, Zhang et al<sup>7</sup> found no difference in rate of complications, mean procedure time, mean operating room time or overall complications in 3640 elective surgeries at a single ambulatory centre. While Goldfarb et al<sup>8</sup> found increased operative and anaesthesia times for simultaneous procedures in 22 220 ambulatory procedures that were statistically significant, the differences were one minute for operative time (57 minutes *versus* 56 minutes) and four minutes for anaesthesia time (97 minutes *versus* 93 minutes), which

are not clinically significant. There was also no difference in complications.<sup>8</sup> Similar findings have been found in the inpatient setting, with a multicentre retrospective study of inpatient orthopaedic operations without increased risk of perioperative complications or 30-day readmission rates.<sup>9</sup> Despite such evidence, patients disagree with overlapping surgery. This identifies an essential area for patient education.

Orthopaedic surgeons disagreed more with the surgeon scheduled concurrently than with the anaesthesiologist. There was less of a difference in agreement regarding anaesthesiologists in concurrent *versus* overlapping operations than with surgeons. These findings may reflect the surgeons' sense that the critical portion of their work is of greater significance, or it may be a reflection of a lack of familiarity with the anaesthesiologist's role.

Disagreement with simultaneous surgery was significantly greater for the surgeon for his or her family member than for his or her patient, although the difference was small. Together with previous findings that parents disagreed with any simultaneity for their children,<sup>4</sup> the greater personal disagreement of surgeons in this study might be a basis for re-evaluation of the ACS position on overlapping surgery. This discrepancy in surgeons should personalize the disparate position of patients regarding overlapping surgery and adds impetus to addressing this agreement gap. On the other hand, small differences, even if statistically significant, on the five-point Likert scale may not be clinically relevant and conclusions or interpretations of this data, therefore, should not be seen as absolute.

Surgeons agreed more about informing patients of concurrent surgery and anaesthesia than about informing them of overlapping cases. In a prior investigation, such a difference in the parents of children undergoing PSIF for AIS was not identified.<sup>4</sup> In fact, parents agreed that they would postpone or even pay a premium to avoid any simultaneity.<sup>4</sup>

The perspectives in this study did not statistically differ by level of training, indicating a fundamental understanding of such practice that is uninfluenced by career experience. When stratifying based on subspecialty, those more experienced with the specific operation (paediatric surgeons and spine surgeons) trended toward more opposition to overlapping surgery and had a significantly smaller difference in opinions between concurrent and overlapping surgery. This may reflect a greater appreciation of the critical nature of supposedly noncritical parts of an operation. These findings also call into question the deference to the surgeon regarding definition of what is critical or noncritical and, therefore, acceptable. One approach would be for each subspecialty to develop standards for each procedure that a surgeon would consider performing simultaneously.

We included residents and all subspecialty orthopaedic surgeons in order to capture a variety of perspectives. Even though PSF for AIS represent a unique subspecialty procedure for a specific diagnosis, the question of simultaneous surgery is one of universal importance to all orthopaedic surgeons. As such, we need a breadth of opinions and discussion to effectively and impartially address the issue. Another approach would be to focus on paediatric spine surgeons. While they may be more knowledgeable of the details of PSF for AIS, their focus may limit the applicability of the results to the broader question of simultaneity. Expanding this area of investigation to include other diagnoses and procedures, in an inclusive and thereby representative manner, will validate the findings and promote consensus, particularly since what defines the 'critical' portion of the case is up to surgeon discretion which may be influenced by level of training/experience, familiarity and case complexity. Current practice at our institution – a large tertiary referral centre in an urban setting – for the procedure discussed (i.e., PSF for AIS) is that no simultaneous surgery, in either overlapping or concurrent form, is performed and the senior surgeon attending is operating directly with a senior resident. However, there are orthopaedic subspecialty practices in which overlapping surgery is a routine part of practice and representatives from these practices were included in the survey.

Our rate of participation was > 70%, which is an acceptable standard. We are unable to, however, due to survey anonymity, discern if the opinions of those who did not participate would influence data in a different direction or if those who did not complete the survey have different practices relating to simultaneous surgery. While similar questions were asked in our previous study of parents regarding PSIF in AIS for their children, direct statistical comparison cannot be performed due to different scaling and survey technique; as a result, only qualitative comparisons can be made. It is important to acknowledge while many data were statistically significant, it is unclear what the clinical relevance of small differences on the five-point Likert scale represent, and results should be interpreted with caution. We studied one surgical department at one institution and inherent biases exist based on the practices in this setting. The validity of our results would improve by increasing numbers and sites. As the survey was directed at surgeons, we were able to capture their perspectives on simultaneous anaesthesia, however, we do not have data from anaesthesiologists on simultaneous surgery, which would have provided additional and possibly more balanced perspective that future studies may investigate. Finally, with regard to trainees, we did not ask about participation during critical portions without supervision because this is not a standard of care. While we did not ask about participation during

noncritical portions with supervision because it can be assumed that this is a standard of surgical training, patients may disagree with this practice. This highlights discrepancy that may exist between the surgical community and its patients.

## Conclusion

Orthopaedic surgeons disagree with concurrent surgery and anaesthesia but agree with overlapping surgery and anaesthesia for PSIF for AIS. Orthopaedic surgeons are in greater agreement that patients should be informed of concurrence than of overlap. They agree less with trainees performing critical parts of an operation, even with supervision, than performing noncritical parts. The surgical community's position regarding overlapping surgery and outcome studies on simultaneous operations must be more effectively presented to the public, in order to bridge the gap in perspectives.

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## COMPLIANCE WITH ETHICAL STANDARDS

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No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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### ETHICAL STATEMENT

**Ethical approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was deemed exempt from the institutional review board of the University of California, San Francisco (IRB # 16-18647).

**Informed consent:** Formal informed consent was not obtained for this study as data was completely anonymized.

### ICMJE CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflict of interest.

### AUTHOR CONTRIBUTIONS

SacA: Conceptualization, Data analysis, Manuscript drafting, Manuscript review.

H-HW: Manuscript drafting, Manuscript review.

SamA: Manuscript drafting, Manuscript review.

TW: Conceptualization, Data management, Manuscript review.

MAK: Data analysis, Manuscript drafting, Manuscript review.

MD: Conceptualization, Manuscript drafting, Manuscript review.

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