



Clinical Studies

Discrepancies in recommendations for return to regular activities after cervical spine surgery: A survey study



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ABSTRACT

Background: The recommended timing for returning to common activities after cervical spine surgery varies widely among physicians based on training background and personal opinion, without clear guidelines or consensus. The purpose of this study was to analyze spine surgeons' responses about the recommended timing for returning to common activities after different cervical spine procedures.

Methods: This was a survey study including 91 spine surgeons. The participants were asked to complete an anonymous online survey. Questions regarding their recommended time for returning to regular activities (showering, driving, biking, running, swimming, sedentary work, and nonsedentary work) after anterior cervical decompression and fusion (ACDF), cervical disc replacement (CDR), posterior cervical decompression and fusion (PCDF), and laminoplasty were included. Comparisons of recommended times for return to activities after each surgical procedure were made based on surgeons' years in practice.

Results: For ACDF and PCDF, there were no statistically significant differences in recommended times for return to any activity when stratified by years in practice. When considering CDR, return to non-sedentary work differed between surgeons in practice for 10 to 15 years, who recommended return at 3 months, and all other groups of surgeons, who recommended 6 weeks. Laminoplasty surgery yielded the most variability in activity recommendations, with earlier recommended return (6 weeks) to biking, non-sedentary work, and sedentary work in the most experienced surgeon group (>15 years in practice) than in all other surgeon experience groups (3 months).

Conclusions: We observed significant variability in surgeon recommendations for return to regular activities after cervical spine surgery.

Introduction

The number of spinal procedures performed globally will continue to increase, especially in the setting of an aging population [1,2]. While multiple goals of spine surgery exist – decreasing pain and disability, improving deformity, minimizing postoperative complications, and minimizing cost, the primary objective is always to improve the patient's quality of life [3,4]. When assessing quality of life, the most basic mea-

sure to consider is a patient's ability to partake in activities of daily living, with the lack of capacity to perform these activities a proven indicator of disability that ultimately affects patient satisfaction [5]. Moreover, after surgery, a large percentage of patients expect to return to their preoperative levels of function, that may include activities such as driving, exercise, and, oftentimes, work [6]. Interestingly, although recommendations are given to every patient in their postoperative course, there remains little to no consensus on when exactly after surgery they

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should be cleared to return to such activities. While studies do exist when considering return to play in athletes after cervical injuries [7,8] and after undergoing single level ACDF [9,10], return to more common, everyday activities, lacks consensus. Much of the reasoning behind recommendations for return to common activities after spinal surgeries are dogmatic and often based on the treating surgeon's personal beliefs or training background, without sound evidence [11].

In this study, we aimed to evaluate, through a survey given to spine surgeons, the general recommendations for the time to return to different activities (showering, driving, biking, running, swimming, sedentary and non-sedentary work) after multiple different types of elective cervical spine surgeries, and to analyze factors affecting differences in these recommendations.

Methods

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and hospital institutional review board exemption approval (IRB#2022-0274) was obtained prior to study recruitment. Written informed consent was waived.

Survey

An anonymous, electronic survey (see full survey in Supplemental Materials section) was administered to spine surgeons. The survey included questions about basic demographic information such as background training, geographic region of practice, board certification status, years in practice, and practice type. The survey also included questions regarding surgeon-specific recommendations for time to return to activities (specifically showering, driving, running, sex, swimming, and sedentary and non-sedentary work) after 4 different types of cervical spine operations: anterior cervical discectomy and fusion (ACDF), cervical disc replacement (CDR), posterior cervical decompression and fusion (PCDF), and laminoplasty.

Recruitment and participants

Recruitment emails with a brief study description and survey link were sent to potential participants identified through contact lists and an institutional listserv. Only surgeons that received the survey invitation could participate; there was no public access to the questionnaire. Inclusion criteria were practicing spine surgeons (orthopedic spine surgeons and neurosurgeons) globally. Responses were collected from July 2022 through November 2022.

Statistical analysis

Counts and percentages were calculated for summarizing the discrete variables. The Fisher's exact test was used to examine the differences in return to activity timing between amongst subgroups of respondents based on years of experience/practice ("years-in-practice" subgroups). Statistical analysis was performed using R-Studio version 2023.03.0 (Posit Software). Statistical significance was defined as $p < .05$.

Results

Demographics

Ninety-one surgeons responded to the survey. Of the respondents, 87 were orthopedic spine surgeons; the remaining 4 were neurosurgeons. A total of 69% of respondents currently practiced in the United States of America (USA), while 31% practiced outside of the USA. Within the USA, there was significant regional variation – 63% of responses were from the Northeast, 16% Southeast, 8% Midwest, and 13% West. Amongst survey respondents, 57% were board-certified, 29% were board-eligible, and 14% were non-board certified at the time of

survey completion. Regarding the years-in-practice subgroups, 23% had more than 15 years, 12% had 10 to 15, 25% had 5 to 10, and 40% had 0 to 5. Finally, 37% of survey respondents noted they practiced in a private practice setting, 36% practiced at an academic medical center, 17% were hospital employed, and 10% noted that they practiced in a hybrid private/academic ("privademic") model.

Return to activities by procedure

ACDF

Of the 91 survey respondents, 73 (80%) completed the section on ACDF. Return to showering after surgery was most commonly reported as postoperative day 3 (38% of responses). The second most common recommendation for showering was postoperative day 1 (32% of responses). The majority of respondents recommended return to driving, sex, and sedentary work, by 2 weeks, whereas for running, swimming, biking, and non-sedentary work, return at 6 weeks was most often recommended. When stratified by years-in-practice subgroups, there were no significant differences in recommendations for any activity (Table 1).

CDR

74 of the survey respondents (81%) completed the section on CDR. Similar to ACDF recommendations, showering after CDR was most commonly recommended on postoperative day 3 (40% of responses), followed by postoperative day 1 (32%). Also similarly, recommendation for return to driving, sex, and sedentary work was most commonly 2 weeks, and 6 weeks for running, biking, swimming, and non-sedentary work. The only significant difference was in recommended return to non-sedentary work, for which the 10-15 years-in-practice subgroup recommended a later return (3 months postoperative) as opposed to the all other subgroups (6 weeks) ($p = .024$) (Table 2).

PCDF

74 of the survey respondents (81%) completed the section on PCDF. Slightly different than ACDF and CDR, the recommended return to showering after PCDF was most commonly reported as postoperative day 3 (37% of responses), with the second most common recommendation being postoperative day 5 (20% responses). Return to driving, swimming, biking and sedentary work was most commonly recommended at 6 weeks postoperatively, with running and non-sedentary work were recommended at 3 months. No significant differences were observed between years-in-practice subgroups (Table 3).

Laminoplasty

A total of 74 of the survey respondents (81%) completed the section on laminoplasty. Exactly similar to PCDF, showering after laminoplasty was most commonly recommended on postoperative day 3 (37% of responses), followed by postoperative day 5 (20%). Return to driving, running, swimming, sex, sedentary work, and non-sedentary work was recommended most commonly at 6 weeks. Regarding biking, the 10 to 15 years-in-practice subgroup recommended returning at 3 months postoperatively, in contrast to the other subgroups, all of which recommended return at 6 weeks ($p = .015$). Similarly, the 10 to 15 years-in-practice subgroup recommended later times for return to both sedentary ($p = .046$) and non-sedentary work ($p = .013$) when compared to all other subgroups (Table 4).

Pooled percentages

Figs. 1–8 demonstrate the pooled percentages of recommended timing for return to all activities listed in the survey after ACDF, CDR, PCDF, and laminoplasty combined (all procedures).

Table 1
Recommended timing for return to activities after ACDF.

Activity	Total responses (n = 73)	0–5 years in practice (n = 28)	5–10 years in practice (n = 18)	10–15 years in practice (n = 11)	≥ 15 years in practice (n = 17)	p-value
Showering						
1 day	24 (32.4%)	11 (39.3%)	3 (16.7%)	3 (27.3%)	7 (41.2%)	.268
3 days	28 (37.8%)	12 (42.9%)	7 (38.9%)	5 (45.5%)	4 (23.5%)	
5 days	11 (14.9%)	4 (14.3%)	4 (22.2%)	1 (9.1%)	2 (11.8%)	
1 week	4 (5.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	3 (17.6%)	
2 weeks	7 (9.5%)	1 (3.6%)	3 (16.7%)	2 (18.2%)	1 (5.9%)	
Driving						
2 weeks	46 (62.2%)	20 (71.4%)	9 (50.0%)	6 (54.5%)	11 (64.7%)	.333
6 weeks	18 (24.3%)	4 (14.3%)	6 (33.3%)	5 (45.5%)	3 (17.6%)	
3 months	10 (13.5%)	4 (14.3%)	3 (16.7%)	0 (0.0%)	3 (17.6%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Running						
2 weeks	8 (10.8%)	3 (10.7%)	2 (11.1%)	0 (0.0%)	3 (17.6%)	.842
6 weeks	33 (44.6%)	11 (39.3%)	8 (44.4%)	7 (63.6%)	7 (41.2%)	
3 months	29 (39.2%)	12 (42.9%)	7 (38.9%)	3 (27.3%)	7 (41.2%)	
6 months	4 (5.4%)	2 (7.1%)	1 (5.6%)	1 (9.1%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Swimming						
2 weeks	9 (12.2%)	2 (7.1%)	5 (27.8%)	0 (0.0%)	2 (11.8%)	.128
6 weeks	42 (56.8%)	18 (64.3%)	7 (38.9%)	8 (72.7%)	9 (52.9%)	
3 months	20 (27.0%)	5 (17.9%)	6 (33.3%)	3 (27.3%)	6 (35.3%)	
6 months	3 (4.1%)	3 (10.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Biking						
2 weeks	24 (32.4%)	10 (35.7%)	7 (38.9%)	0 (0.0%)	7 (41.2%)	.400
6 weeks	31 (41.9%)	10 (35.7%)	8 (44.4%)	6 (54.5%)	7 (41.2%)	
3 months	18 (24.3%)	7 (25.0%)	3 (16.7%)	5 (45.5%)	3 (17.6%)	
6 months	1 (1.4%)	1 (3.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Sex						
2 weeks	39 (53.4%)	15 (55.6%)	8 (44.4%)	8 (72.7%)	8 (47.1%)	.788
6 weeks	23 (31.5%)	9 (33.3%)	6 (33.3%)	2 (18.2%)	6 (35.3%)	
3 months	11 (15.1%)	3 (11.1%)	4 (22.2%)	1 (9.1%)	3 (17.6%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Sedentary work						
2 weeks	57 (77.0%)	22 (78.6%)	14 (77.8%)	7 (63.6%)	14 (82.4%)	.762
6 weeks	15 (20.3%)	5 (17.9%)	3 (16.7%)	4 (36.4%)	3 (17.6%)	
3 months	2 (2.7%)	1 (3.6%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Non-sedentary work						
2 weeks	8 (11.0%)	3 (10.7%)	2 (11.1%)	0 (0.0%)	3 (17.6%)	.231
6 weeks	38 (52.1%)	19 (67.9%)	9 (50.0%)	4 (40.0%)	6 (35.3%)	
3 months	27 (37.0%)	6 (21.4%)	7 (38.9%)	6 (60.0%)	8 (47.1%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	

Significant p-values are expressed in bold.
ACDF, anterior cervical discectomy and fusion.

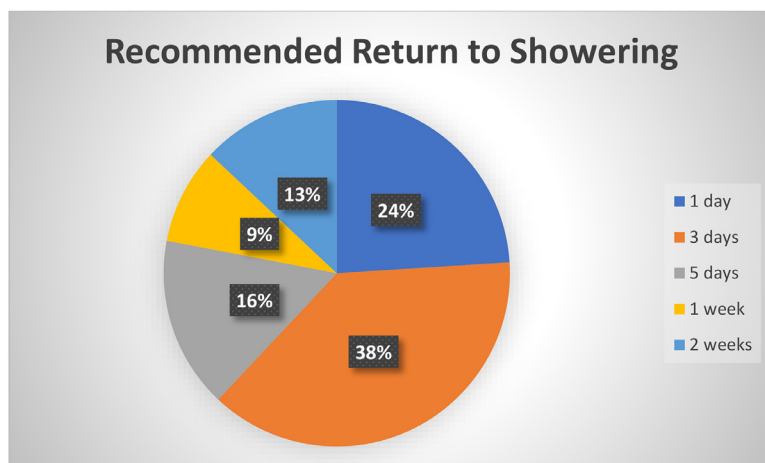


Fig. 1. Pooled percentages of recommended timing for return to showering after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

Table 2
Recommended timing for return to activities after CDR.

Activity	Total (n = 73)	0–5 years in practice (n = 27)	5–10 years in practice (n = 18)	10–15 years in practice (n = 11)	≥ 15 years in practice (n = 17)	p-value
<i>Showering</i>						
1 day	23 (31.5%)	11 (40.7%)	3 (16.7%)	3 (27.3%)	6 (35.3%)	.524
3 days	29 (39.7%)	12 (44.4%)	7 (38.9%)	5 (45.5%)	5 (29.4%)	
5 days	7 (9.6%)	2 (7.4%)	3 (16.7%)	0 (0.0%)	2 (11.8%)	
1 week	6 (8.2%)	0 (0.0%)	2 (11.1%)	1 (9.1%)	3 (17.6%)	
2 weeks	8 (11.0%)	2 (7.4%)	3 (16.7%)	2 (18.2%)	1 (5.9%)	
<i>Driving</i>						
2 weeks	40 (54.8%)	19 (70.4%)	7 (38.9%)	5 (45.5%)	9 (52.9%)	.243
6 weeks	22 (30.1%)	5 (18.5%)	6 (33.3%)	6 (54.5%)	5 (29.4%)	
3 months	10 (13.7%)	3 (11.1%)	4 (22.2%)	0 (0.0%)	3 (17.6%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Running</i>						
2 weeks	12 (16.4%)	6 (22.2%)	2 (11.1%)	0 (0.0%)	4 (23.5%)	.575
6 weeks	38 (52.1%)	16 (59.3%)	8 (44.4%)	6 (54.5%)	8 (47.1%)	
3 months	19 (26.0%)	4 (14.8%)	6 (33.3%)	4 (36.4%)	5 (29.4%)	
6 months	3 (4.1%)	1 (3.7%)	1 (5.6%)	1 (9.1%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Swimming</i>						
2 weeks	12 (16.4%)	6 (22.2%)	4 (22.2%)	0 (0.0%)	2 (11.8%)	.591
6 weeks	41 (56.2%)	16 (59.3%)	7 (38.9%)	8 (72.7%)	10 (58.8%)	
3 months	17 (23.3%)	4 (14.8%)	5 (27.8%)	3 (27.3%)	5 (29.4%)	
6 months	2 (2.7%)	1 (3.7%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Biking</i>						
2 weeks	28 (38.4%)	12 (44.4%)	9 (50.0%)	0 (0.0%)	7 (41.2%)	.147
6 weeks	30 (41.1%)	12 (44.4%)	4 (22.2%)	8 (72.7%)	6 (35.3%)	
3 months	13 (17.8%)	2 (7.4%)	4 (22.2%)	3 (27.3%)	4 (23.5%)	
6 months	1 (1.4%)	1 (3.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Sex</i>						
2 weeks	41 (56.2%)	17 (63.0%)	8 (44.4%)	8 (72.7%)	8 (47.1%)	.742
6 weeks	22 (30.1%)	7 (25.9%)	7 (38.9%)	2 (18.2%)	6 (35.3%)	
3 months	8 (11.0%)	2 (7.4%)	2 (11.1%)	1 (9.1%)	3 (17.6%)	
6 months	1 (1.4%)	1 (3.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Sedentary work</i>						
2 weeks	56 (76.7%)	22 (81.5%)	13 (72.2%)	6 (54.5%)	15 (88.2%)	.324
6 weeks	14 (19.2%)	4 (14.8%)	3 (16.7%)	5 (45.5%)	2 (11.8%)	
3 months	2 (2.7%)	1 (3.7%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Non-sedentary work</i>						
2 weeks	10 (13.7%)	7 (25.9%)	2 (11.1%)	0 (0.0%)	1 (5.9%)	.024
6 weeks	41 (56.2%)	18 (66.7%)	9 (50.0%)	4 (36.4%)	10 (58.8%)	
3 months	21 (28.8%)	2 (7.4%)	6 (33.3%)	7 (63.6%)	6 (35.3%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	

Significant p-values are expressed in bold.
CDR, cervical disc replacement.

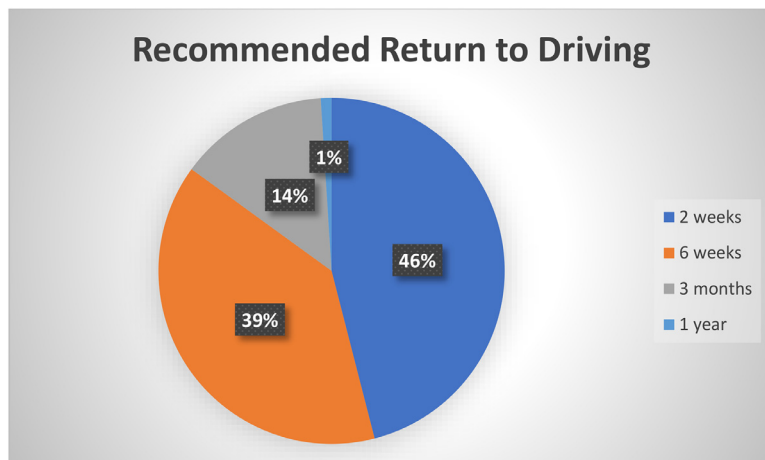


Fig. 2. Pooled percentages of recommended timing for return to driving after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

Table 3
Recommended timing for return to activities after PCDF.

Activity	Total (n = 74)	0–5 years in practice (n = 28)	5–10 years in practice (n = 18)	10–15 years in practice (n = 11)	≥ 15 years in practice (n = 17)	p-value
<i>Showering</i>						
1 day	11 (14.9%)	7 (25.0%)	1 (5.6%)	1 (9.1%)	2 (11.8%)	.234
3 days	27 (36.5%)	6 (21.4%)	7 (38.9%)	6 (54.5%)	8 (47.1%)	
5 days	15 (20.3%)	9 (32.1%)	3 (16.7%)	1 (9.1%)	2 (11.8%)	
1 week	9 (12.2%)	2 (7.1%)	2 (11.1%)	1 (9.1%)	4 (23.5%)	
2 weeks	12 (16.2%)	4 (14.3%)	5 (27.8%)	2 (18.2%)	1 (5.9%)	
<i>Driving</i>						
2 weeks	18 (24.3%)	8 (28.6%)	3 (16.7%)	2 (18.2%)	5 (29.4%)	.220
6 weeks	40 (54.1%)	15 (53.6%)	7 (38.9%)	9 (81.8%)	9 (52.9%)	
3 months	15 (20.3%)	5 (17.9%)	7 (38.9%)	0 (0.0%)	3 (17.6%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Running</i>						
2 weeks	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	.258
6 weeks	22 (29.7%)	8 (28.6%)	2 (11.1%)	3 (27.3%)	9 (52.9%)	
3 months	39 (52.7%)	14 (50.0%)	12 (66.7%)	7 (63.6%)	6 (35.3%)	
6 months	11 (14.9%)	6 (21.4%)	2 (11.1%)	1 (9.1%)	2 (11.8%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Swimming</i>						
2 weeks	4 (5.4%)	0 (0.0%)	3 (16.7%)	1 (9.1%)	0 (0.0%)	.144
6 weeks	33 (44.6%)	14 (50.0%)	5 (27.8%)	4 (36.4%)	10 (58.8%)	
3 months	31 (41.9%)	13 (46.4%)	6 (33.3%)	6 (54.5%)	6 (35.3%)	
6 months	5 (6.8%)	1 (3.6%)	3 (16.7%)	0 (0.0%)	1 (5.9%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Biking</i>						
2 weeks	12 (16.2%)	4 (14.3%)	4 (22.2%)	0 (0.0%)	4 (23.5%)	.468
6 weeks	30 (40.5%)	12 (42.9%)	4 (22.2%)	5 (45.5%)	9 (52.9%)	
3 months	28 (37.8%)	11 (39.3%)	8 (44.4%)	6 (54.5%)	3 (17.6%)	
6 months	3 (4.1%)	1 (3.6%)	1 (5.6%)	0 (0.0%)	1 (5.9%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Sex</i>						
2 weeks	23 (31.1%)	5 (17.9%)	6 (33.3%)	6 (54.5%)	6 (35.3%)	.093
6 weeks	38 (51.4%)	20 (71.4%)	7 (38.9%)	4 (36.4%)	7 (41.2%)	
3 months	11 (14.9%)	3 (10.7%)	3 (16.7%)	1 (9.1%)	4 (23.5%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	2 (2.7%)	0 (0.0%)	2 (11.1%)	0 (0.0%)	0 (0.0%)	
<i>Sedentary work</i>						
2 weeks	26 (35.1%)	9 (32.1%)	5 (27.8%)	1 (9.1%)	11 (64.7%)	.122
6 weeks	40 (54.1%)	17 (60.7%)	10 (55.6%)	8 (72.7%)	5 (29.4%)	
3 months	7 (9.5%)	2 (7.1%)	2 (11.1%)	2 (18.2%)	1 (5.9%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Non-sedentary work</i>						
2 weeks	2 (2.7%)	0 (0.0%)	2 (11.1%)	0 (0.0%)	0 (0.0%)	.202
6 weeks	18 (24.3%)	9 (32.1%)	3 (16.7%)	1 (9.1%)	5 (29.4%)	
3 months	47 (63.5%)	17 (60.7%)	10 (55.6%)	9 (81.8%)	11 (64.7%)	
6 months	5 (6.8%)	2 (7.1%)	1 (5.6%)	1 (9.1%)	1 (5.9%)	
1 year	2 (2.7%)	0 (0.0%)	2 (11.1%)	0 (0.0%)	0 (0.0%)	

Significant p-values are expressed in bold.
PCDF, posterior cervical decompression and fusion.

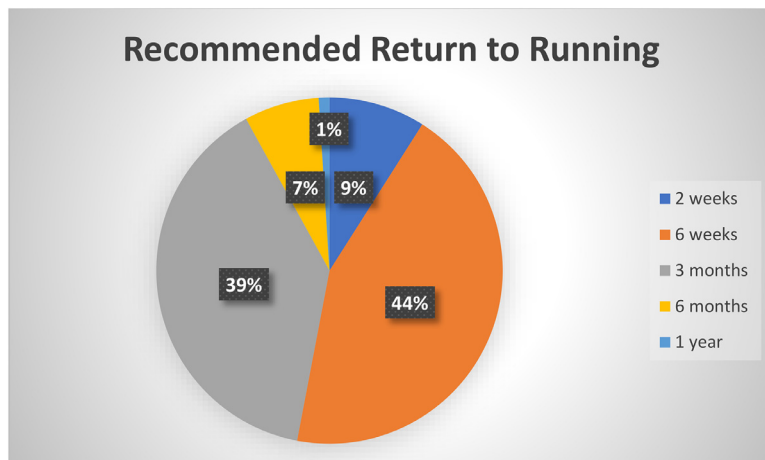


Fig. 3. Pooled percentages of recommended timing for return to running after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

Table 4
Recommended timing for return to activities after laminoplasty.

Activity	Total (n = 74)	0–5 years in practice (n = 28)	5–10 years in practice (n = 18)	10–15 years in practice (n = 11)	≥ 15 years in practice (n = 17)	p-value
<i>Showering</i>						
1 day	13 (17.6%)	8 (28.6%)	2 (11.1%)	1 (9.1%)	2 (11.8%)	.255
3 days	27 (36.5%)	6 (21.4%)	7 (38.9%)	5 (45.5%)	9 (52.9%)	
5 days	15 (20.3%)	9 (32.1%)	2 (11.1%)	2 (18.2%)	2 (11.8%)	
1 week	9 (12.2%)	3 (10.7%)	2 (11.1%)	1 (9.1%)	3 (17.6%)	
2 weeks	10 (13.5%)	2 (7.1%)	5 (27.8%)	2 (18.2%)	1 (5.9%)	
<i>Driving</i>						
2 weeks	31 (41.9%)	14 (50.0%)	6 (33.3%)	2 (18.2%)	9 (52.9%)	.483
6 weeks	36 (48.6%)	11 (39.3%)	10 (55.6%)	8 (72.7%)	7 (41.2%)	
3 months	6 (8.1%)	3 (10.7%)	1 (5.6%)	1 (9.1%)	1 (5.9%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Running</i>						
2 weeks	4 (5.6%)	1 (3.7%)	2 (11.8%)	0 (0.0%)	1 (5.9%)	.239
6 weeks	37 (51.4%)	16 (59.3%)	6 (35.3%)	3 (27.3%)	12 (70.6%)	
3 months	28 (38.9%)	10 (37.0%)	7 (41.2%)	7 (63.6%)	4 (23.5%)	
6 months	2 (2.8%)	0 (0.0%)	1 (5.9%)	1 (9.1%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.9%)	0 (0.0%)	0 (0.0%)	
<i>Swimming</i>						
2 weeks	4 (5.4%)	0 (0.0%)	3 (16.7%)	0 (0.0%)	1 (5.9%)	.194
6 weeks	47 (63.5%)	19 (67.9%)	9 (50.0%)	6 (54.5%)	13 (76.5%)	
3 months	21 (28.4%)	9 (32.1%)	4 (22.2%)	5 (45.5%)	3 (17.6%)	
6 months	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Biking</i>						
2 weeks	14 (18.9%)	4 (14.3%)	3 (16.7%)	0 (0.0%)	7 (41.2%)	.015
6 weeks	45 (60.8%)	19 (67.9%)	12 (66.7%)	5 (45.5%)	9 (52.9%)	
3 months	14 (18.9%)	5 (17.9%)	2 (11.1%)	6 (54.5%)	1 (5.9%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Sex</i>						
2 weeks	26 (35.1%)	9 (32.1%)	4 (22.2%)	6 (54.5%)	7 (41.2%)	.695
6 weeks	39 (52.7%)	16 (57.1%)	11 (61.1%)	4 (36.4%)	8 (47.1%)	
3 months	8 (10.8%)	3 (10.7%)	2 (11.1%)	1 (9.1%)	2 (11.8%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Sedentary work</i>						
2 weeks	34 (45.9%)	14 (50.0%)	6 (33.3%)	1 (9.1%)	13 (76.5%)	.046
6 weeks	35 (47.3%)	13 (46.4%)	10 (55.6%)	9 (81.8%)	3 (17.6%)	
3 months	4 (5.4%)	1 (3.6%)	1 (5.6%)	1 (9.1%)	1 (5.9%)	
6 months	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	
<i>Non-sedentary work</i>						
2 weeks	5 (6.8%)	1 (3.6%)	3 (16.7%)	0 (0.0%)	1 (5.9%)	.013
6 weeks	36 (48.6%)	19 (67.9%)	4 (22.2%)	2 (18.2%)	11 (64.7%)	
3 months	31 (41.9%)	8 (28.6%)	10 (55.6%)	9 (81.8%)	4 (23.5%)	
6 months	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.9%)	
1 year	1 (1.4%)	0 (0.0%)	1 (5.6%)	0 (0.0%)	0 (0.0%)	

Significant p-values are expressed in bold.

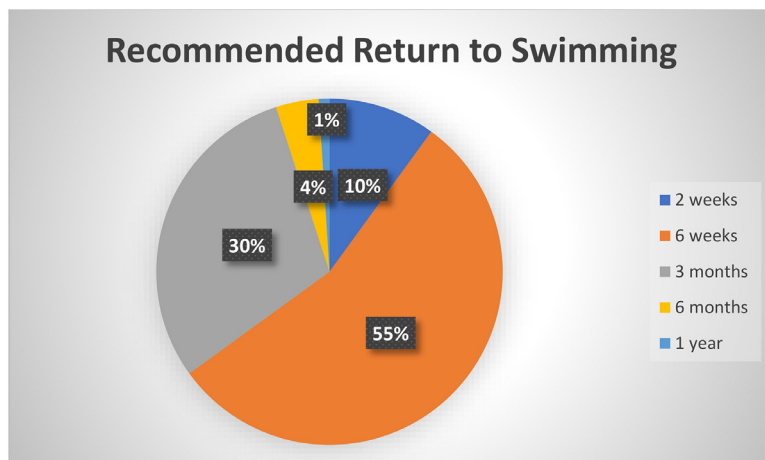


Fig. 4. Pooled percentages of recommended timing for return to swimming after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

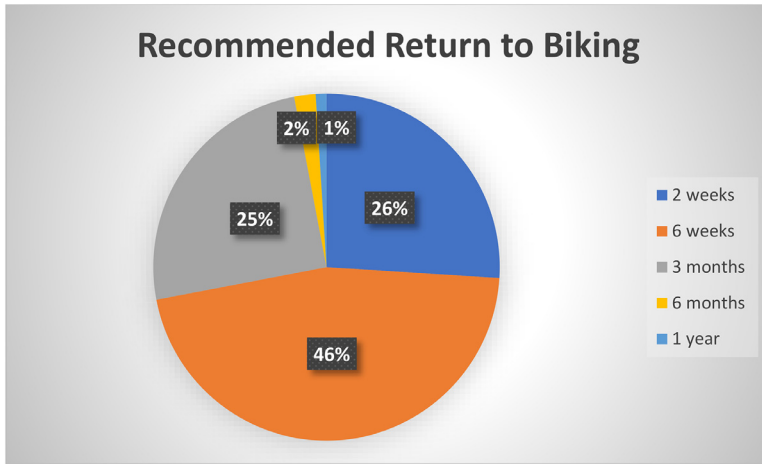


Fig. 5. Pooled percentages of recommended timing for return to biking after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

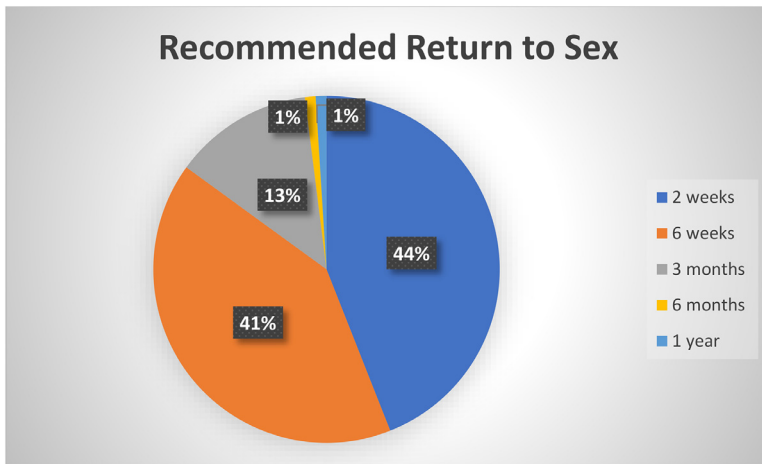


Fig. 6. Pooled percentages of recommended timing for return to sex after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

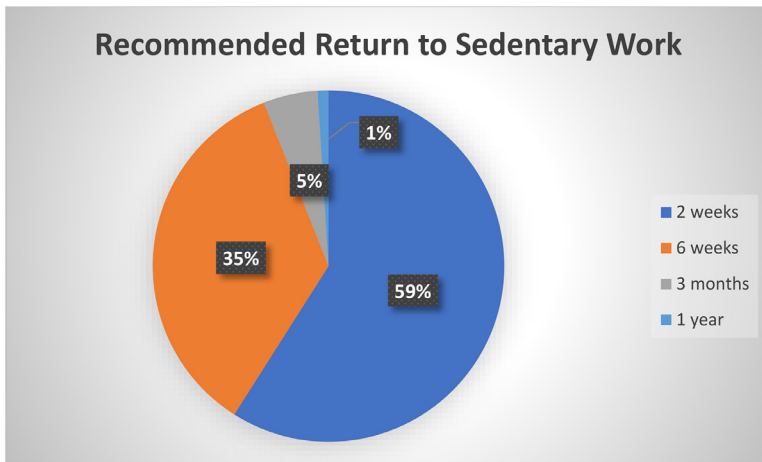


Fig. 7. Pooled percentages of recommended timing for return to sedentary work after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

Discussion

The recommended timing for returning to regular activities in the general population after cervical spine surgery has not been standardized. While basic science research has helped to establish reasonable expectations for healing (soft tissues and bony tissues) at different timepoints postoperatively, standardization of recommendations for returning to actual life activities remains elusive. For instance, one can generally expect the re-epithelialization of surgical wounds to take 14 to 21 days (2–3 weeks) [12]. Yet while the patient’s incision may be successfully healed in just a few weeks, bony fusion requires a much

longer period of time, with estimates ranging from 12 weeks to upwards of 12 months postoperatively [13,14]. This lack of clear consensus on when exactly surgeons can expect healing of the soft tissues and bones postoperatively has contributed to a dearth of evidence supporting an “optimal” timing to return to regular activities after surgery of the cervical spine. Because of this, current recommendations to patients are made largely based on the surgeon’s background training and common sense, however without clear supporting scientific evidence. In this study we aimed to highlight, by means of a survey provided to spine surgeons, any discrepancies in recommendations for return to regular activities after 4 common surgical procedures of the cervical spine.

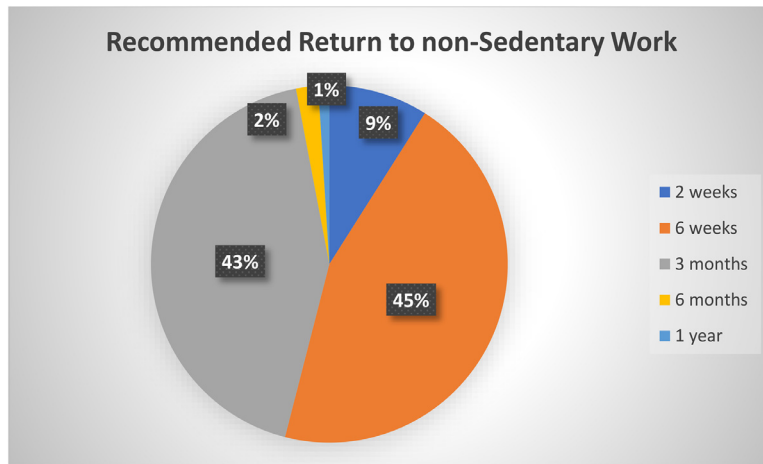


Fig. 8. Pooled percentages of recommended timing for return to non-sedentary work after ACDF, CDR, PCDF, and laminoplasty. ACDF, anterior cervical discectomy and fusion; CDR, cervical disc replacement; PCDF, posterior cervical decompression and fusion.

To our knowledge, there are no well-defined guidelines regarding the timing of returning to common activities in the general population after cervical spine surgery. Most of the existing guidelines are specific to athletes returning to sport. For example, Leider et al. studied return to play in elite athletes after spine surgery in a systematic review including 13 studies and a total of 349 athletes who underwent ACDF, CDR, or PCDF [10]. The authors demonstrated a higher rate of return to play with surgical compared to conservative management, and noted that return to play after surgical intervention was safe. Separately, Molinari et al. [9], in a systematic review including a total of 175 athletes, concluded that the existing literature supports a high rate of successful return to sport and pre-surgery performance level after one-level ACDF surgery for cervical disc herniations. Neither study suggested a concrete timeline for when exactly these patients should return.

And while the literature on athletes' return to sport is rather thin, guidelines on return to common activities remains even more sparse. Guglielmi et al. [15] surveyed 56 spine surgeons regarding the optimal timing to return to activities of daily living (driving, biking, heavy labor) after ACDF and posterior cervical foraminotomy procedures. In their study, the average recommended time to return to driving was 4 to 6 weeks after a one-level ACDF, and 6 weeks after a multilevel ACDF or posterior cervical foraminotomy. This same study noted an average postoperative return to biking after 1 or 2-level ACDF or posterior cervical foraminotomy at 4 weeks, and at 6 weeks for ACDF of 3 levels or greater. Lastly, for heavy labor (akin to non-sedentary work in our study), the authors reported an average recommendation of returning to activity after 6 weeks for foraminotomy, 8 weeks for one-level ACDF, 8 to 12 weeks for 2-level ACDF, and 3 months for ACDF of 3 or more levels. This study highlights contradictions and similarities in its findings when compared to our results. The survey completed in our study on recommended return to driving demonstrated 2 weeks as the most common response (over 60%), yet also saw a wide range of survey responses (range: 2 weeks to 3 months), which just further underscores the discrepancies in medical discharge and return to activities. However, when considering timing for recommended return to biking and non-sedentary labor, our study fared relatively similarly in comparison, in which the most common response was 6 weeks (however at just 42%), with responses ranging from 2 weeks to 6 months. While our study did not stratify ACDF by 1, 2, or 3 or more levels, the most common response for recommended return to non-sedentary work after ACDF in general was 6 weeks (52% of responses). Again, however, responses to this survey question ranged widely, from 2 weeks (11% of responses) up to 3 months (37% of responses). All in all, when compared to the available literature, our survey study results demonstrated generally earlier recommended time to return to activities, typically by the order of roughly 2 weeks. It is unclear exactly the reason for this trend towards earlier recommended return to activities – differences in patient populations,

practice settings, and surgeon experience are a few possible explanations.

Our results highlighted some similarities and many differences between recommended timing for return to activities after different surgical spine operations. ACDF was most consistent with CDR, both anterior-based cervical procedures. PCDF and laminoplasty, both posterior-based cervical procedures, did not show quite the degree of similarity in their results, with recommended return to sedentary and non-sedentary work both longer in the PCDF group (a fusion) than in the laminoplasty group (a motion-sparing procedure).

Regarding the influence of years in practice and return to activities timing, our results provide for interesting discussion. With ACDF, we found no significant differences among surgeons, independent of their years in practice, in any of the activities evaluated. These results differ from those of Moses et al. [11], in which the authors surveyed 71 spine surgeons about recommendations for return to driving after multiple cervical spine surgeries – ACDF, PCDF, CDR, isolated cervical laminectomy, and cervical foraminotomy. The authors noted that experienced surgeons – defined as those with more than 15 years in practice – recommended patients to return to driving approximately 2 weeks earlier than their less experienced colleagues. In our study, recommended time to return to driving yielded no significant differences among surgeons of different experience. The notion that more experienced surgeons may allow patients to return to activities earlier in their postoperative courses was noted in our study for certain activities specific to certain surgeries. Biking after laminoplasty, for instance, saw 41% of experienced surgeons (>15 years in practice) recommending patients return after 2 weeks, versus the remains subgroups of surgeons, all of which favored a return at 6 weeks. Additionally, the more experienced surgeon subgroup recommended that patients return to non-sedentary work earlier than the less-experienced surgeons for CDR, and both sedentary and non-sedentary work after laminoplasty. The reasons for these differences are likely multifactorial, with more robust experience, confidence in fixation, and optimal patient selection likely all contributing factors.

While our study initially sought to clarify recommendations for timing of return to common, every day activities after an array of cervical spine operations, it became abundantly clear early in the data collection process that a lack of consensus in the survey responses was the most obvious, and notable, finding. While we did come across a few significant trends in our results, one must look no further than Figs. 1–8, which underscore the immense variation and clear lack of consensus in how surgeons make recommendations for postoperative restrictions and activity clearance in this patient population. Evaluating Figs. 1–8, one can note that only 2 (return to swimming and sedentary work) of the 8 activities studied have the most common survey response at a rate over 50%. In the remaining 6 pie charts, this number ranges from 38% to 46%. Many explanations exist for the significant ranges and variabilities in the survey responses. These include diversity in location of practice – our sur-

vey included just under 1/3 of international surgeon responses, years in practice as was previously highlighted, type of practice, and variations in medical training – although neurosurgeons accounted for less than 5% of survey respondents, thus the impact of this remains unknown. Additionally, other factors such as differences in surgical techniques, requirements for postoperative collar wear, and cultural and patient-specific characteristics, to name a few, were not addressed specifically in this survey study yet certainly have the potential to contribute to postoperative recommendations.

Another important point to consider is the diversity in recommendations for motion-sparing operations, such as CDR. One recent 2023 study evaluated return to sport and active-duty military requirements (both, clearly, at least akin to non-sedentary work in our survey) and found a return to sport training in 100% of patients at an average of 10 weeks and a return to duty in the military population in 88% of patients at an average of 11 weeks [16]. This was in line with our survey results, which found the most common recommendation for return to non-sedentary work to be 6 weeks for less experienced surgeons, and 3 months for the longer-in-practice surgeon subgroup. And, looking more granularly, this study showed a return to running in more than 50% of patients by 6 weeks, which was the most common recommended time to return to running in our survey. While this was not a survey study thus is not methodologically similar, it is important to consider alongside the growing popularity of motion-sparing surgical options such as CDR. One would hypothesize that due to the nature and presumed benefits of motion-sparing operations, the treating surgeons may allow for earlier return to activities, sport, and work.

Our study is not without its limitations. First, this is a survey study, which was sent to many spine surgeons via institutional listservs, however without knowledge of exactly how many received it, and thus an inability to calculate a true response rate. Inherent to this process, there is the potential for bias (sampling bias, response bias) to be introduced. Secondly, of the 91 respondents, only 4 were neurosurgeons, accounting for less than 5% of the total respondents, which may limit the applicability to their field – although, the fields of orthopedic spine surgery and neurosurgery do overlap quite significantly in modern medicine. Third, we chose 4 of the most common cervical spine surgeries, and chose not to include all – namely isolated cervical laminectomy and posterior cervical foraminotomy. Additionally, we lumped all ACDF procedures into one category, and recognize the potential added information that could have been received and analyzed had we chosen to stratify ACDF by number of levels fused. And finally, while we provided a comprehensive survey evaluating 4 different surgeries and eight different activities, there always exist opportunities to improve the granularity of the data. For instance, we chose not to specify showering with or without a bandage, or sedentary and on-sedentary work with or without limitations. While we considered these details in the development of the survey, we anticipated these fine details may precipitate survey fatigue on participants who typically shoulder an already-overwhelming administrative burden on a regular basis.

The strengths of our study include primarily the size of the study. At 91 respondents, this is larger than any existing study on this area of interest. A second strength of our study is its international breadth, with 30% of survey respondents practicing outside of the USA, which lies in contrast to other existing literature on the topic, in which most if not all of the survey respondents practiced inside the USA. We believe that this international flavor, in addition to surgeon respondents with different levels of practice experience (from 0 years of practice to greater than 15), contributes to generalizability of our results.

Conclusions

The recommended timing for returning to regular activities after cervical spine surgery remains significantly variable, without clear scientific evidence to support any one surgeon's decision-making for when to allow patients to return to specific activities. While there did exist a

few significant differences amongst recommendations for times to start individual activities, largely the most impressive result was the significant variability and overt lack of consensus, without any clear connection to years in training or location of practice. It appears evident that future studies would be welcome to provide scientific support to providing sound and safe postoperative guidance after cervical spine surgery. Potential directions for future research on this topic include prospective studies to evaluate patient outcomes (both clinical – patient satisfaction, etc. and radiographic – fusion rates, etc.) based on early or delayed return to specific activities. Although it is likely that wide differences in surgeons' recommendations for return to activities will always exist with significant variability, due to differences in training, regional cultures, levels of experience and more, we do believe that unified recommendations would provide greater clarity and peace of mind to patients while in the midst of their postoperative recoveries.

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Declaration of competing interest

All of the authors note no relationships or conflicts pertaining to the submitted manuscript. One or more authors declare financial interests or personal relationships outside of the submitted work as specified on required ICMJE-NASSJ Disclosure Forms and outlined here. Dr. Cammisa does disclose relevant financial activities outside the submitted work: Royalties, Stock Ownership, Private Investments, Consulting, Board of Directors, Scientific Advisory Board, Research Support (4Web Medical, Camber Spine, Centinel Spine). Dr. Girardi does disclose relevant financial activities outside the submitted work: Royalties, Stock Ownership, Private Investments. Dr. Hughes does disclose relevant financial activities outside the submitted work: Stock Ownership, Research Support (Nuvasive Inc., Kuros Biosciences, Kuros Biosurgery, Expanding Innovations). Dr. Sama does disclose relevant financial activities outside the submitted work: Royalties, Private investments, Consulting, Speaking and/or Teaching Arrangements, Scientific Advisory Board, Research Support (Spinal Kinetics).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.xnsj.2024.100316](https://doi.org/10.1016/j.xnsj.2024.100316).

References

- [1] Rajae SS, Kanim LEA, Bae HW. National trends in revision spinal fusion in the USA: patient characteristics and complications. *Bone Joint J* 2014;96-B(6):807–16.
- [2] Deyo RA, Gray DT, Kreuter W, Mirza S, Martin BI. United States trends in lumbar fusion surgery for degenerative conditions. *Spine (Phila Pa 1976)* 2005;30(12):1441–5 discussion 1446–7.
- [3] Camino Willhuber G, Elizondo C, Shullitel P. Analysis of postoperative complications in spinal surgery, hospital length of stay, and unplanned readmission: application of Dindo-Clavien classification to spine surgery. *Global Spine J.* 2019;9(3):279–86 accessed date July 26, 2018. doi:10.1177/2192568218792053.
- [4] Chotai S, Parker SL, Sivaganesan A, Godil SS, McGirt MJ, Devin CJ. Quality of life and general health after elective surgery for cervical spine pathologies: determining a valid and responsive metric of health state utility. *Neurosurgery* 2015;77(4):553–60 discussion 560.
- [5] Beighley A, Zhang A, Huang B, et al. Patient-reported outcome measures in spine surgery: a systematic review. *J Craniovertebr Junction Spine* 2022;13(4):378–89.
- [6] Kim EJ, Chotai S, Wick JB, et al. Factors associated with return-to-work following cervical spine surgery in non-worker's compensation setting. *Spine (Phila Pa 1976)* 2019;44(13):903–7.
- [7] Cantu RC, Baines JE, Wilberger JE. Guidelines for return to contact or collision sport after a cervical spine injury. *Clin Sports Med* 1998;17(1):137–46.
- [8] Swiatek PR, Nandurkar TS, Maroon JC, et al. Return to play guidelines after cervical spine injuries in American football athletes: a literature-based review. *Spine (Phila Pa 1976)* 2021;46(13):886–92.

- [9] Molinari RW, Pagarigan K, Dettori JR, Molinari R, Dehaven KE. Return to play in athletes receiving cervical surgery: a systematic review. *Global Spine J* 2016;6(1):89–96.
- [10] Leider J, Piche JD, Khan M, Aleem I. Return-to-play outcomes in elite athletes after cervical spine surgery: a systematic review. *Sports Health* 2021;13(5):437–45.
- [11] Moses MJ, Tishelman JC, Hasan S, et al. Lack of consensus in physician recommendations regarding return to driving after cervical spine surgery. *Spine (Phila Pa 1976)* 2018;43(20):1411–17.
- [12] Coger V, Million N, Rehbock C, et al. Tissue concentrations of zinc, iron, copper, and magnesium during the phases of full thickness wound healing in a rodent model. *Biol Trace Elem Res* 2019;191(1):167–76.
- [13] Boden SD. Overview of the biology of lumbar spine fusion and principles for selecting a bone graft substitute. *Spine (Phila Pa 1976)* 2002;27(16 Suppl 1):S26–31.
- [14] Boden SD, Schimandle JH, Hutton WC, Chen MI. Volvo Award in basic sciences. The use of an osteoinductive growth factor for lumbar spinal fusion. Part I: Biology of spinal fusion. *Spine (Phila Pa 1976)* 1995;20(24):2626–32.
- [15] Guglielmi GN, Seibly JM. Return to work guidelines following neurosurgical procedures. *Cureus* 2020;12(12):e11982.
- [16] Reiter CR, Nelson CT, Satalich JR, et al. Return to sport and active military duty after cervical disc arthroplasty: a systematic review. *J Orthop* 2023;39:75–82.