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Original Article

A study of attributable variables impacting orthopedic trauma surgical training

Rajeev Shukla, Vishal Singh Champawat*, Ravi Kant Jain

Department of Orthopedics, Sri Aurobindo Medical College and PG Institute, Indore, Madhya Pradesh, India

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ABSTRACT

Purpose: In medical colleges, resident training programs must provide adequate surgical experiences, making them qualified at the end of residency program. It is generally believed that it would take more time for a surgical resident to perform surgical procedures than a board-certified surgeon. There is no current benchmark with regards to operative time and surgical cases involving orthopedic surgery residents. In this study, we focused on two key aspects of surgical training variables, namely, surgical duration & C-arm shoots when the procedure is done by a faculty surgeon in comparison to done by an orthopedic resident under supervision of faculty surgeon.

Methods: It is an observational prospective study, we observed patients undergoing 1 of 5 common orthopedic trauma operations in a community teaching hospital. We recorded two variables, 'skin to skin' surgical duration & number of image intensifier television/C-arm shoots of faculty surgeons and orthopedic resident (postgraduate-3yr) under supervision of faculty surgeon. We calculated mean difference of two variables with or without resident & determined statistical significance, we also compared functional outcome at final follow-up.

Results: The total number of procedure observed was 402. On observing summarized results of all surgical procedures, faculty surgeons took on an average 33 min lesser ($p < 0.05$) & on an average 37 lesser number of shoots ($p < 0.05$) than resident surgeons. The difference in surgical duration tended to increase with the greater complexity of the surgical dissection. The difference in number of C-arm shoots tended to increase with the increase in surgical duration in closed procedures. In all the five procedures there was no significant difference ($p > 0.05$) in functional outcome of cases performed by faulty surgeon and resident.

Conclusion: Little data has been previously published regarding the impact of teaching orthopedic resident in operating room. We demonstrate that resident participation increases the procedure time for commonly performed orthopedic procedures and also the number of C-arm shoots, hence there is a need for technical training facilities outside the operating room such as in cadaveric labs, saw bone labs & virtual surgery simulation. Also the preoperative plan should be thoroughly discussed by faculty surgeon with residents.

Introduction

Medical colleges have the main responsibility for training surgical residents. In medical colleges, resident training should provide adequate surgical experiences thus making them qualified at the end of orthopedic residency. The common belief is that an orthopedic resident takes more time to perform a trauma surgery than a faculty surgeon. This difference in surgical duration has been documented in orthopedic trauma surgery.[1]

The increase in surgical duration leads to increase in cost burden. Hands-on experience is required for adequate training of surgical residents.[2]

Fluoroscopy is commonly used in orthopedic trauma surgery and has led to reduction in operative time and increase in surgical precision.[3] Overuse of fluoroscopy leading to radiation exposure above permissible limits has ill effect on health of surgeon.[4] Surgeons and other operative room personnel are at risk due to this casual approach.

There are many attributable factors which impact orthopedic surgical training. In this study, we focused on two key aspects of surgical training variables, namely, surgical duration & C-arm shoots when the procedure is done by a faculty surgeon in

* Corresponding author.
E-mail address: vishal.champawat@gmail.com (V.S. Champawat).
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comparison to done by an orthopedic resident under supervision of faculty surgeon.

We hypothesize that there is an increase in the amount of time required to perform an operation and increase in number of C-arm shoots when the procedure involves training an orthopedic resident.

Methods

This study is an observational analysis of prospectively collected data on patients undergoing 1 of 5 common orthopedic trauma surgical procedures that an orthopedic trauma surgery resident would be expected to complete in a residency in a community teaching hospital. Patients included in this study were more than 18 years of age and had only closed fractures. We recorded two variables 'skin to skin' surgical duration and number of c-arm shoots of faculty surgeons and orthopedic resident (postgraduate-3yr) under supervision of faculty surgeon performing 5 common orthopedic surgical procedures in a community teaching hospital between 1st October, 2015 and 30th April, 2018. We calculated mean difference of two variables with or without resident & determined statistical significance, we also compared functional outcome of all the 5 procedures after dividing them into two groups (I. procedure done by faculty surgeon, II. procedure done by resident).

Results

At any point of time during our study there were 10 faculty surgeon and 6 postgraduate-3yr residents in the study. A total of 402 cases were observed during the duration of study.

In all of the five procedures faculty surgeon took less number of C-arm shoots and the duration taken by faculty surgeon was less when compared to that of residents.

In our study in treatment of fracture shaft femur treated by close reduction internal fixation (CRIF) with intramedullary nail, the training resident took mean 80 more C-arm shoots & took mean 38 min more when compared to faculty surgeon. There was no significant functional outcome difference at 1 year follow-up according to Harris hip score ($p = 0.64$) & Lysholm knee score ($p = 0.70$).

In treatment of fracture shaft tibia treated by CRIF with intramedullary nail, the training resident took mean 21 more C-arm shoots & took mean 40 min more when compared to faculty surgeon. There was no significant functional outcome difference at 1 year follow-up according to Johner-Wruh's criteria.

In treatment of fracture distal radius treated by CRIF with K-wire, the training resident took mean 23 more C-arm shoots & took mean 22 min more when compared to faculty surgeon. There was no significant functional outcome difference at 1 year follow-up according to disability of arm, shoulder and hand (DASH) score ($p = 0.51$).

In treatment of fracture shaft radius, ulna treated by open reduction internal fixation (ORIF) with plating, the training resident took mean 45 min more when compared to faculty surgeon. There was no significant functional outcome difference at 1 year follow-up according to DASH score ($p = 0.21$).

In treatment of fracture medial malleolus treated by ORIF with canulated cancellous (CC) screw, the training resident took mean 18 more C-arm shoots & took mean 22 min more when compared to faculty surgeon. There was no significant functional outcome difference at 1 year follow-up according to The American Orthopedic Foot & Ankle Society (AOFAS) hindfoot-ankle score ($p = 0.23$).

Maximum difference in mean C-arm shoots was found in fracture shaft femur (CRIF with intramedullary nail), which was 80 shoots (Table 1); minimum difference was found in fracture distal radius (CRIF with K-wire), which was 23 shoots (Table 2). Maximum difference in mean surgical duration (in minutes) was found in fracture shaft radius, ulna (ORIF with plating), which was 45 min (Table 3). Minimum difference in mean surgical duration (in minutes) was found in fracture distal radius (CRIF with K-wire), which was 20 min. Results of fracture shaft tibia (CRIF with intramedullary nail) & fracture medial malleolus (CC-screw) is given in Tables 4 and 5 respectively.

On observing summarized results of all surgical procedures (Table 6), faculty surgeons took 33 min lesser than resident surgeons on an average, which was statistically significant ($p < 0.05$).

We also observed a statistically significant ($p < 0.05$) difference of 37 mean number of shoots between faculty surgeon & resident surgeons, with faculty surgeon taking lesser number of shoots.

In all the five procedures there was no significant difference ($p > 0.05$) in functional outcome of cases performed by faculty surgeon and resident.

Discussion

The learning of surgical skills in orthopedic surgery is paramount in training of residents. The best way to acquire the surgical skills is to "learn by doing".

We have demonstrated significant difference in operative time & number of C-arm shoots between orthopedic faculty surgeon & postgraduate-3yr resident. The difference in number of C-arm shoots tended to increase with the increase in surgical duration in closed procedures. The difference in surgical duration tended to increase with the greater complexity of the surgical dissection

Table 1
Fracture shaft femur (CRIF with intramedullary nail).

Fracture shaft femur	Number of cases	Mean number of shoots	Mean surgical duration (min)	Mean Harris hip score at 1 year follow-up	Mean Lysholm knee score at 1 year follow-up
Faculty surgeon	45	90 (76–110)	72 (55–85)	92	83
Resident	33	170 (128–225)	110 (95–120)	91	79
Difference	12	80	38	$p = 0.64$	$p = 0.70$

Table 2
Fracture shaft tibia (CRIF with intramedullary nail).

Fracture shaft tibia	Number of cases	Mean number of shoots	Mean surgical duration (min)	Mean Johner-Wruh's criteria at 1 year follow-up
Faculty surgeon	28	25 (17–25)	48 (40–60)	Excellent: 24 (86%); Good: 3 (11%); Fair 1 (3%)
Resident	53	46 (32–54)	88 (60–110)	Excellent: 46 (87%); Good: 5 (9%); Fair 2 (4%)
Difference	25	21	40	–

Table 3
Fracture distal radius (CRIF with K-wire).

Fracture distal radius	Number of cases	Mean number of shoots	Mean surgical duration (min)	Mean DASH score at 1 year follow-up
Faculty surgeon	31	17 (12–28)	30 (25–40)	7.48 ± 1.67
Resident	78	40 (23–75)	50 (40–80)	8.51 ± 1.49
Difference	47	23	20	$p = 0.51$

Table 4
Fracture shaft radius, ulna (ORIF with plating).

Fracture shaft radius, ulna	Number of cases	Number of shoots	Mean surgical duration (min)	Mean DASH score at 1 year follow-up
Faculty surgeon	39	–	55 (45–70)	14.5 ± 2.9
Resident	28	–	100 (80–115)	17.9 ± 4.4
Difference	11	–	45	$p = 0.21$

Table 5
Fracture medial malleolus (ORIF with CC-screw).

Fracture medial malleolus	Number of cases	Mean number of shoots	Mean surgical duration (min)	Mean AOFAS hindfoot-ankle score at 1 year follow-up
Faculty surgeon	30	28 (22–35)	40 (30–55)	96.7 ± 5.55
Resident	37	46 (39–54)	62 (50–80)	94.6 ± 5.52
Difference	7	18	22	$p = 0.23$

Table 6
Summarized result of all five procedures.

	Number of cases	Mean number of shoots (where applicable)	Mean surgical duration (min)
Faculty surgeon	173	42	49
Resident	229	75	82
Difference	56	37	33
p value	–	0.001	0.001

(shaft radius, ulna plating took longer than medial malleolus CC-screw fixation).

The increased time surgeon takes in operating room is the lost time, which he may spend in seeing patients, teaching and doing research work.

The differences noted in operative time & number of C-arm shoots not only confine the patient to longer periods in the operating room, but also impart a financial impact in terms of direct cost incurred. Also because all operation theatre personnel are at increased risk to ionizing radiation due to increase in C-arm shoots, they may lead to secondary occupational health hazards.

Karam et al.[5] in their study documented that both 80% of orthopedic residency program directors and 86% of residents agreed that surgical skill simulations should become a required part of training to learn basic surgical skills through repeated practice away from the direct patient care.

We could not find any study analyzing attributable variables impacting orthopedic surgical training, though similar studies have been done in other surgical fields.

In conclusion, few data have been previously published regarding the attributable variables impacting orthopedic surgical training. The surgical education of trainees is vital for the future of our specialty, a key mission of teaching hospitals, and a primary focus for academic surgeons. There is a need for technical training facilities outside the operating room such as in cadaveric labs, saw bone labs & virtual surgery simulation should become a required part of training. Also the preoperative plan should be thoroughly discussed by faculty surgeon with residents. Future studies may provide insight into optimal strategies for promoting resident education in the operative room while simultaneously maximizing surgical volume and efficiency.

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Ethical statement

This study has been approve by the local ethics committee.

Conflicts of interest

The authors declare no conflicts of interest.

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