Learning Curves in Arthroplasty in Orthopedic Trainees

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The NHS is adapting to a changing environment, in which economical constraints have forced theatres to maximise efficiency. An environment in which working hours and surgical exposure has been reduced and outcomes are being published. Litigation is high, and patients are living longer with higher demands. We ask, will traditional methods of apprentiship type training suffice in producing competent arthroplasty surgeons when hands on experience is falling. We review learning curves and assessment tools available to accurately assess competency and support trainee orthopaedic surgeons in their acquisition of surgical proficiency. (J Surg Ed 73:689-693. Crown Copyright © 2016 Published by Elsevier Inc. on behalf of the Association of Program Directors in Surgery. All rights reserved.)

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INTRODUCTION

As the National Health Service adapts to a changing world, where people are living longer with higher expectations; but where economical constraints have forced hospitals to reexamine processes to maximize efficiency—much attention is on orthopedic training.

The world health organization projects that by 2020 osteoarthritis would be the fourth leading cause of disability.[1] Unsurprisingly, the number of performed total hip replacements (THRs) and total knee replacements (TKRs) are placing increasing pressures on hospitals, in their challenge to manage waiting times.[2] Thus, consultant orthopedic surgeons are increasingly finding themselves torn between achieving targets and providing adequate training and sufficient load exposure to produce competent surgeons.

Traditionally, orthopedic surgeons undertook an apprenticeship type training program, in which they would start by assisting, then would be observed and supervised until they were competent to perform arthroplasty surgery unsupervised. It was assumed that the trainee would become competent in hip and knee arthroplasty by completion of a predetermined length of training.

The concern with this model of training is that the patient may not receive the highest level of surgery from a relatively inexperienced surgeon, which may translate to poorer clinical outcomes. This has become even more relevant with the data on individual consultant outcomes now being published. Naturally, the result would be more consultant performed procedures, and less hands-on experience during specialty training, especially during the early years. Together with the implementation of the European working time directive,[3] National inquiry into Patient Outcomes and Deaths,[4] Modernizing Medical Careers (MMC), [5] and the Joint Committee in Surgical Training surgical education in the United Kingdom has been revisited.

Similar changes have been reported in the United States, and a recent study has revealed that surgical trainees report having very few supervised operative experiences in basic procedures deemed essential by their program directors.[6]

With the introduction of the working time directive, the reduction in out of hours operating, the development of MMC, and development of the new specialist training programs (ST 1-7) there is marked concern that surgeons are entering consultant positions with significantly less experience than their predecessors. Analysis of log books from 2004 suggested that MMC reduced the number of primary THRs and TKRs performed by trainees from 37 and 44 to 22 and 24, respectively.[7] A further study published in Ann R Coll Surg Eng showed that SpRs performed almost 35% less TKRs after the Independent Sector Treatment Centres were operational.[8]

With training moving toward a competency based framework and a modern orthopedic curriculum that involves significantly less hands-on experience, a better understanding of learning, and skill acquisition is essential. What is more there a need to fully use alternative techniques to aid in learning and assessment to ensure these competencies are truly achieved.

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Simulation appears to be emerging as a useful tool, but has been critized for its poor transferability to the operative setting.

This article reviews current available evidence on learning curves of junior orthopedic surgeons embarking on hip and knee arthroplasty surgery. We would clarify the learning curve and review its reported effect on surgical outcomes of orthopedic trainees when compared with consultant surgeons. We would also review tools and methods of assessing competency.

UNDERSTANDING THE LEARNING CURVE

When learning a new procedure, performance usually improves with experience. Graphically plotting performance against experience produces a learning curve. Initially, the gradient of ascent indicates how quickly the clinician is improving. As the degree of improvement attained with each case reduces as technique is refined, overall performance begins to tail off. A point is then reached when the individual is able to perform the procedure independently and still achieve the same good outcomes. Further experience still improves performance by small amounts until a plateau is reached.[9]

In surgery, there are potentially dramatic implications of misjudging a surgeon or units position on the learning curve. Recent examples include the Oxford Paediatric Cardiac death inquiry and the General Medical Council inquiry into the Bristol Paediatric Surgical Unit, who stated that "patients should not be exposed to Surgeons at the start of their learning curves."[10]

Measures of learning curves in arthroplasty can be broadly divided into measures of the surgical process and measures of patient outcomes, for example, length of stay, transfusion requirements, functional outcomes, and morbidity An extensive review of the literature revealed a very few published data specifically plotting the learning curves of trainee surgeons in arthroplasty surgery. There is also little evidence to support the use of one of these outcome measures over another in the assessment of learning.

Within training, the challenge is providing enough time and exposure to facilitate universal achievement of competency. A variety of teaching and assessment strategies must be employed to support this process. As supervised training opportunities dwindle newly appointed consultants must recognize their position on the learning curve and the need for further training, structured appraisal and senior mentorship.

THE LEARNING CURVE AND CLINICAL OUTCOMES

Several recent studies have compared clinical and radiographic outcomes of THRs and TKRs performed either by a consultant or a trainee (supervised and unsupervised). A commonly cited prospective randomized trial of THRs using the Stanmore and Charnley prostheses showed that unsupervised trainees had higher revision rates than those completed by an orthopedic consultant.[11] In a study of 2906 hip hemiarthroplasties performed by senior registrars, junior registrars, or senior house officers (SHO), Unwin and Thomas[12] found higher dislocation rates for junior registrars, and highest in SHOs. However, there is good recent evidence that supervised trainees can achieve similar surgical results when compared with consultant orthopedic surgeons. Mahaluxmivala et al.[13] looked at 673 press fit condylar posterior cruciate sacrificing TKRs. They assessed surgeon experience against radiographic parameters for component positioning. They concluded that there was no difference between supervised trainees and consultants. In addition, Moran et al. reported no difference in the Harris Hip scores for THRs performed by specialist registrars vs. consultant at up to 18 months of follow-up.[14] A multicentre prospective study of 1501 THRs performed either by a specialist registrar or consultant published in the JBJS(Br) concluded that there was no difference in functional outcome scores at up to 5 years follow-up.[15] They also reported no difference in complications including dislocation rates. They did, however, report a statistically significant difference ($p < 0.001$) in operating time between the 2 groups, with a mean difference of 28 minutes (shorter duration in consultant group), and the length of hospital stay ($p = 0.22$), 9.8 days in the consultant group, and 11 days in the registrar group. Interestingly, they also divided the registrar group into senior and junior registrars, and reported an Oxford hip score of 25.2 at 5 years follow-up in the senior registrar group that was significantly higher than ($p = 0.001$) than that in the junior registrar group (Oxford hip score = 21.8). However, there was no difference in complication or revision rate.[15]

These findings are reassuring to the public and to trainers. Supervised trainees are consistently found to be achieving comparable clinical results to consultants when performing arthroplasty surgery This suggests that the learning curve of trainee surgeons should not compromise the quality of the surgery provided.

There has previously been some concern regarding the greater length of time required for trainee surgeons. A total of 31 Norwegian study based on 745 THRs showed that the mean operating time for cemented hip arthroplasty was 96 minutes.[16] Operating times greater than 96 minutes were associated with greater revision rates for aseptic loosening, and those greater than 150 minutes were associated with increased rates of infection. However, this was not replicated by Palan et al.,[15] a multicentre prospective study of 1501 THAs.

What is clear is the key is, supervision appropriate to the trainee's level of experience. Older studies have shown greater complication rates and inferior clinical outcomes when joint replacement surgery is performed by unsupervised trainees still on the learning curve.[12,17]

There is little consensus on how many times a particular procedure must be performed to achieve competency for