Foot and Ankle Surgery 18 (2012) 62–65

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

Is there a learning curve in foot and ankle surgery?

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ARTICLE INFO

Article history:
Received 17 November 2010
Received in revised form 8 March 2011
Accepted 15 March 2011

Keywords:
Foot and ankle
Learning curve
Education
Training
Functional outcome

ABSTRACT

Background: Previous studies of orthopaedic learning curves have largely described the introduction of new techniques to experienced consultants. End points have usually involved technical considerations. A paucity of evidence surrounds foot and ankle surgery. This study investigates the learning curve during a foot and ankle surgeon's first year, defined by functional outcome.
Methods: 150 patients underwent elective foot or ankle surgery during the whole period. Preoperative and 6 month postoperative functional scores were compared between the first and second 6 month groups.
Results: Functional improvement was greater, approaching significance, in the second group ($p = 0.0605$). There was no difference for forefoot cases ($p = 0.345$). Functional improvement was significantly greater in the second group with forefoot cases removed ($p = 0.0333$).
Conclusions: A learning curve exists in the first year of practice of foot and ankle surgery, demonstrated by functional outcome. This is confined to ankle, hindfoot and midfoot, but not forefoot surgery.

1. Introduction

The concept of a learning curve is well recognised within many surgical fields [1–4]. The underlying theory is that patient outcome will improve in proportion to increasing surgeon experience.

In support of the concept of a learning curve in its most basic form, Leopold et al. have studied the acquisition of the relatively basic psychomotor skill of knee injection. They conclude convincingly that performance improves with increased instruction and experience [5].

Evidence pertaining to learning curves within orthopaedic surgery is largely centred around arthroplasty. Studies of uncemented total hip replacement have shown a lower rate of surgical complications and improved femoral canal fit along with acetabular cup angle in cases performed later in the learning curve [6,7]. Both studies failed to show any difference in clinical outcome. In a large series of 650 hip resurfacings, Nunley et al. have shown that early complications occurred less frequently following the first 25 cases performed by experienced hip surgeons [8]. Optimal component positioning was achieved more frequently after the first 75–100 cases and this finding is corroborated by Witjes et al. [9]. Thorey et al. have shown the learning curve in acetabular cup positioning to be present also with the use of imageless navigation [10]. Further evidence for a learning curve in hip surgery is provided by Patel et al., who displayed a higher rate of subsidence in their early experience of distally fixed modular stems in revision hip arthroplasty [11]. To break the emphasis on elective surgery, Bjorgul et al. have recently published evidence of a learning curve effect on operative time in hip fracture surgery performed by orthopaedic trainees [12].

Evidence within the field of knee surgery also relates to arthroplasty. Santini has published data indicating that survival of total knee replacements improves with increasing experience following the commencement of independent practice [13]. Further data is largely centred on minimally invasive knee arthroplasty. Two studies have shown operative time to decrease in proportion to increasing number of cases [14,15]. While Song et al. have published evidence of a learning curve effect on implant failure [16], other studies contradict this [14,17]. Rees et al. have suggested that clinical outcome is better following the first 10 cases [18].

There has been a recent vogue towards the study of learning curves in pedicle screw placement in spinal surgery. 4 studies all showed that accuracy increased with surgeon experience [19–22]. Gonzalvo et al. showed a statistical improvement in screw accuracy within the first 25 cases, but not beyond that stage

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1268-7731/$ – see front matter.
doi:10.1016/j.fas.2011.03.007

[23]. There has also been interest in learning curves in endoscopic scoliosis surgery. Evidence exists to show decreasing operative time, irradiation time, blood loss and perioperative complications along with an improvement in percentage curve correction, with an increase in the number of cases performed [24–26].

There is a paucity of evidence surrounding the presence of a learning curve within foot and ankle surgery as a whole. In contrast, 5 relevant studies were found on the subject of total ankle arthroplasty. The specific prosthesis varied between the literature. 4 of these studies suggested that a learning curve was present. Murnaghan has noted a higher rate of complications in early cases, but the sample size of 22 cases inhibits statistical analysis [27]. Two further studies of 50 cases each have suggested a learning curve effect on perioperative complications, although 13 of the 50 cases presented by Schuberth et al. included a concomitant bony realignment procedure, which may influence the data [28,29]. Haskell has documented the early experience of 10 surgeons with total ankle replacement, presenting a mean number of 12.8 cases per surgeon. Despite the relatively low number of cases per surgeon, a statistically significant difference was observed between early and late cases, in terms of perioperative complications and time taken for wound healing [30]. In contrast, Spirt et al. found no evidence to support the presence of a learning curve effect on implant survival [31]. It should be noted that this study had a significantly larger study population (306 cases). None of these studies investigated functional outcome.

120 displaced intraarticular calcaneal fractures underwent operative treatment in a study by Sanders et al. They showed that the number of patients who achieved a ‘good’ or ‘excellent’ clinical result increased from 27% to 84% over the first 4 years [32]. A systematic literature review by Poeze et al. failed to reveal any further evidence surrounding learning curves, but did show that increased institutional fracture load led to improved outcome in the operative treatment of calcaneal fractures [33].

The current evidence pertaining to learning curves within orthopaedics is heavily weighted towards end points such as operative time, postoperative complications and implant survival. There is little evidence concerning the effect of a learning curve on functional outcome. The only study of this nature found within foot and ankle surgery was that of Sanders et al. [32]. Although their findings support a learning curve effect on functional outcome, the outcome measure used was subjective and did not involve a standardised scoring system. 2 orthopaedic papers were found which used standardised functional scores to provide evidence for the learning curve effect on functional outcome; Rees et al. found this phenomenon to be present in minimally invasive unicompartmental knee replacement, while Callaghan et al. showed that it was not present in uncemented primary total hip replacement [6,18].

There is a trend towards the study of the introduction of specific procedures to experienced orthopaedic consultants. Much less evidence exists pertaining to the learning curve experienced by newly appointed consultants within their routine workload. The data published by Santini demonstrates that within a consultant’s first 99 total knee replacements, 3 of 4 implant failures within 10 years occurred in the first 6 cases [13]. This suggests a dramatic learning curve within the first year of independent practice of knee surgery. No such evidence was found relating to foot and ankle surgery.

This study tests the null hypothesis that there is no learning curve effect on functional outcome in the routine caseload of a newly appointed foot and ankle consultant surgeon. By presenting the data obtained, it will be possible to elicit any such learning curve and therefore to highlight the need for strategies to facilitate integration into independent practice.

2. Methods

All patients who underwent elective foot and ankle surgery within the first 12 months of a newly appointed foot and ankle consultant surgeon’s practice were included. The surgeon was also performing knee surgery at that time (knee cases were excluded from the study). The surgeon concerned had just finished a 6 month fellowship period in the United States of America. Cases were stratified as ankle, hindfoot, midfoot and forefoot. Caseload was compared between the 2 periods with the Pearson’s Chi square test.

Pain (40 points)	
• None	40
• Mild, occasional	30
• Moderate, daily	20
• Severe, almost always present	0
Function (45 points)	
Activity limitations, support	
• No limitations, no support	10
• No limitations of daily activities, limitation of recreational activities, no support	7
• Limited daily and recreational activities, cane	4
• Severe limitation of daily and recreational activities, walker, crutches, wheelchair	0
Footwear requirements	
• Fashionable, conventional shoes, no insert required	5
• Comfort footwear, shoe insert	3
• Modified shoes or brace	0
Maximum walking distance, 100 yards	
• Greater than 6	10
• 4 – 6	7
• 1 – 3	4
• Less than 1	0
Walking surfaces	
• No difficulty on any surface	10
• Some difficulty on uneven terrain, stairs, inclines, ladders	5
• Severe difficulty on uneven terrain, stairs, inclines, ladders	0
Gait abnormality	
• None, slight	10
• Obvious	5
• Marked	0
Total Score	**85**

Fig. 1. Modified AOFAS midfoot score.