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The Effect of Obesity and Increasing Age on Operative Time and Length of Stay in Primary Hip and Knee Arthroplasty

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ABSTRACT

We retrospectively reviewed 589 patients undergoing lower-limb arthroplasty, recording age, body mass index (BMI) and co-morbidities. The effect of these on operative duration and length of stay (LOS) was analysed. For a 1 point increase in BMI we expect LOS to increase by a factor of 2.9% and mean theatre time to increase by 1.46 minutes. For a 1-year increase in age, we expect LOS to increase by a factor of 1.2%. We have calculated the extra financial costs associated. The current reimbursement system underestimates the financial impact of BMI and age. The results have been used to produce a chart that allows prediction of LOS following lower limb arthroplasty based on BMI and age. These data are of use in planning operating lists.

As a population the UK is becoming older and increasingly obese. Data released in 2012 revealed that 26.2% of the UK adult population is obese (i.e. body mass index (BMI) >30 kg/m^2) compared to 13.2% in 1993 [1]. The Office for National Statistics has demonstrated both increases in the median age and the proportion of older people in the UK population [2].

It is well recognised that obesity is a risk factor for developing lower limb osteoarthritis [3,4]. Whilst obesity leads to a future increased risk of both hip and knee arthroplasty [5], knees appear more susceptible to degenerative disease in the obese patient [6] with each unit of age-adjusted BMI associated with a 4% increase in knee osteoarthritis [7] and an odds ratio of developing osteoarthritis of 9.3 with a BMI in excess of 30 kg/m^2 [4].

The National Joint Registry (NJR) [8] supports this observation, demonstrating that the number of elective primary hip and knee arthroplasty procedures performed in obese patients (BMI >30 kg/m^2) is increasing. 26% of patients undergoing primary hip arthroplasty in 2011 were obese compared with 21% in 2004 [9]. 32% of patients that received a total knee arthroplasty (TKA) in 2011 were obese compared with 28% in 2004 [8].

The impact of obesity and increasing age on the outcome of joint arthroplasty surgery remains controversial. The current difficult financial climate has led to an increasing drive towards reducing costs within the UK National Health Service (NHS) and, in a future where we are facing the use of patient reported outcome measures (PROMs) data to reimburse trusts on a Payment by results Basis (PbR), it is important that the full impact of obesity and age on arthroplasty surgery is realised.

Perceptions of poorer outcomes and increased financial costs associated with joint arthroplasty surgery in the obese patient have already lead to some trusts within the UK and abroad rationing hip and knee arthroplasty surgery, barring access to patients with a BMI over 30 kg/m^2 [6,9]. Despite increased complication rates, poorer implant survivorship and potentially worse long-term functional outcomes, obese patients do benefit from arthroplasty surgery [10–12] It is therefore difficult to justify withholding this surgery based on BMI alone. Performing hip and knee arthroplasty surgery in obese patients is associated with increased costs [13,14] and it is important that trusts understand the reason for these increased costs, address any modifiable factors and adjust tariffs accordingly in order to allow appropriate levels of financial remuneration.

In line with the ageing UK population the number of primary joint arthroplasties performed in the elderly patient group is set to continue to increase and the financial implication of this needs to be fully appreciated. In addition to this escalating requirement for surgery, advanced patient age has been shown to be associated with a slower post-operative rehabilitation [15] and an increased length of stay [16–18] although the extent of this appears variable.

In our orthopaedic unit there is a perception that operative time in hip and knee arthroplasty surgery takes longer in obese patients and these patients take longer to recover resulting in an increased length of stay (LOS). There is good evidence that operative time is longer in

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morbidly obese patients; however, the extent of the time difference is controversial [19,20]. It was our aim to quantify this in our unit to allow appropriate planning of operative lists, preventing list overruns and patient cancellations. The evidence surrounding LOS in obese patients following arthroplasty surgery is less clear with some studies demonstrating significantly increased stays [21,22] whilst others report no difference [23,24].

We therefore aimed to assess the relationship between both operative duration and LOS for obese patients in our unit. The effect of increasing age on LOS was also investigated with the aim being to use both BMI and age to pre-operatively predict LOS in our trust.

Methods

We retrospectively reviewed all primary hip and knee arthroplasties performed in our unit in a one year period (2010). Our unit forms part of a UK training hospital managing a trauma and elective workload. Patients were identified through our database (CSC Galaxy Surgery), and the case notes of each patient were reviewed. The operation notes for each procedure were reviewed and all complex primary arthroplasty procedures were identified and excluded from this study. For total hip arthroplasties (THAs) complex primaries were deemed to be procedures that required acetabular bone grafting or augments or where intra-operative fractures occurred requiring fixation. For total knee arthroplasties (TKAs) complex primary procedures were cases involving the use of augments or more constrained prostheses and the occurrence of intra-operative fractures. The grade of surgeon and the level of supervision of junior surgeons were recorded. Procedures performed by all grades of surgeon were included in this analysis.

Each patient's age was recorded, and their pre-operative BMI and co-morbidities were identified from the anaesthetic assessment. Specific co-morbidity indexes or the ASA grade had not been routinely documented at anaesthetic assessment and therefore the individual co-morbidities for each patient were recorded. The case notes also revealed the date of discharge and therefore the LOS for that patient.

Our theatre administration system (CSC Galaxy Surgery) was interrogated in order to reveal the theatre time (not including anaesthetic time) for each procedure. This time includes the time required to transfer the patient from the anaesthetic room, position and drape the patient, perform the preoperative and postoperative cheques, and move the patient from theatres at the end of the case.

To assess the impact of BMI on theatre time, we fitted a linear regression model on theatre time, with effects for BMI and type of joint arthroplasty (hip or knee). To assess the impact of BMI on length of stay, we fitted a linear regression model on log-transformed (base 10) length of stay, with effects for BMI, patient age, type of joint arthroplasty and patient co-morbidities. Analyses were carried out using the software package 'R' [25].

Results

589 consecutive primary hip and knee arthroplasties were reviewed. This included 305 THAs and 284 TKAs. 53 THAs and 30 TKAs were excluded following review of the operation note, as they were considered to be complex primary joint arthroplasties as defined above.

The total number of hip arthroplasties analysed was 252. The number of knee arthroplasties analysed was 254. The patient cohort characteristics are shown in Table 1.

The procedures were performed by 15 different primary surgeons. This cohort comprised 8 consultant orthopaedic surgeons, 2 associate specialists and 5 specialist registrars operating under consultant supervision.

Linear regression of theatre time showed a statistically significant change in mean theatre time with BMI and type of joint arthroplasty. For a patient with an approximately average BMI of 30 kg/m^2, the expected theatre time is 122 minutes for a THA and 110 minutes for a TKA. A 5-point increase in BMI is expected to increase theatre time by approximately 7 minutes ($P < 0.0001$) (Table 2) (Graph 1).

Linear regression of $\log_{10}$-transformed length of hospital stay showed statistically significant effects on mean log-length of stay with patient age, BMI and co-morbidities but not with type of joint arthroplasty (Table 3). The expected length of stay, for a patient of approximately average age (70 years) and BMI (30 kg/m^2) with no co-morbidities, is approximately 4.3 days for THAs and 4.1 ($=4.311 \times 0.948$) days for TKAs. This difference is not statistically significant. For a 10-year increase in age, we expect length of stay to increase by a factor of 13% ($P < 0.0001$). For a 5-point increase in BMI, we expect length of stay to increase by a factor of 15% ($P < 0.001$). Patients with cardiac comorbidities are expected to have an increased length of stay, by a factor of 14%. These effects equate to roughly half of a day over a typical stay of 4 days.

The results of this study have been incorporated into separate charts for total hip and total knee arthroplasties which incorporate both BMI and age in order to predict the length of stay for that patient (Chart 1).

Discussion

The effect of obesity and increasing age in hip and knee arthroplasty surgery has been extensively investigated and remains controversial.

Hip and knee arthroplasty surgery in the obese patient may be associated with increased complications. Significantly higher rates of deep infection [7,26] and superficial wound infections [10] have been reported. Long term implant survivorship is reduced with higher rates of implant failure [27,28] and revision surgery [29] attributed to increased wear rates with greater load application [30], and increased rates of

Table 1
Patient Cohort Characteristics.

	Total Identified	Number Excluded	Involved in Study	Average BMI	Average Age
THA	305	53	252	29.7	71.9
TKA	284	30	254	30.3	71.5

	BMI						
	16–18.5	18.5–25.5	25.5–30.5	30.5–35.5	35.5–40.5	40.5–50.5	>50.5
THA	5	57	96	57	20	9	8
TKA	0	51	86	77	31	9	0

	Age									
	<50.5	50.5–55.5	55.5–60.5	60.5–65.5	65.5–70.5	70.5–75.5	75.5–80.5	80.5–85.5	85.5–90.5	>90.5
THA	6	7	16	28	42	61	49	27	13	3
TKA	3	5	21	43	47	52	40	28	14	1