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Experiences and outcomes in shoulder replacements in a district general hospital over 19 years

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Background: This study aimed to evaluate the changing experiences of shoulder surgeons working in a district general hospital.
Methods: A consecutive series of 395 shoulders (225 male, 170 female) over a 19-year period (2000–2019) with a minimum follow-up of 2 years were analyzed. Outcome measures were length of stay, operating time, satisfaction visual analog score (VAS), pain VAS, Oxford Shoulder Score (OSS), Constant-Murley score, range of movement, complications, and implant survival.
Results: The incidence of a diagnosis of osteoarthritis as the surgical indication increased over time. The number of cases by surgeon per year increased from three cases in 2,000 to a peak of 33 in 2011. Up to seven implant manufacturers were used. The incidence of hemiarthroplasties decreased, and more numerous reverse polarity and anatomic arthroplasties were performed (P<0.001). More glenoid and humeral components were cemented and more short-stem implants were used in later years (P<0.001). Length of stay was a median of 1 day with a trend towards daytime surgery in recent years. Patients were satisfied (VAS 8/10) and OSS improved by 8 points on average throughout the observation period.
Conclusions: Despite frequent introductions of new implants, patient outcome, satisfaction, and complication rates remained good. There appears to be a need for large-scale, generalizable studies to understand why technological advancements leading to changes in implants do not influence clinical outcomes.
Level of evidence: III.

Keywords: Shoulder; Arthroplasty; Hospitals; District

INTRODUCTION

There is evidence to suggest that arthroplasty patients from higher volume surgeons have better functional outcomes, reduced length of stay (LOS), and fewer complications [1,2]. Arthroplasty design, instrumentation and surgical techniques have evolved over recent years to improve accurate component placement, restore anatomy, and balance soft tissue tension [3-5]. The indications for shoulder replacement have expanded with the increasing use of reverse total shoulder replacement (RTSR) in the treatment of proximal humeral fractures [6] and irreparable rotator cuff tears [7]. This has led to changes in decision making and a need for updated surgical skills.

National joint registries in six countries have been collecting data on outcomes for shoulder prostheses since 1994, with more than 10,000 entries with good outcomes and continuing improvement [8]. The Norwegian Arthroplasty Register reported 5- and 10-year failure rates of hemiarthroplasties of 6% and 8%, respectively [9]. The New Zealand Joint Registry suggests that the need for revision shoulder implantation was most likely within 2

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years after the operation; data for a longer follow-up have yet to be obtained [8]. However, incomplete data and erroneous reporting reduce the reliability of registry findings, and data are not collected in relation to poorly performing implants that have yet to be revised [7].

The aim of this study is to understand the impact of increasing surgical volume and changes in practice over time on patient experience and outcomes, measured using LOS, operating time, satisfaction visual analog score (VAS), pain VAS, Oxford Shoulder Score (OSS), Constant score, range of movement, complications, and implant survival in a single district general hospital over 19 years. This study presents a pragmatic commentary on the impact of the evolution of shoulder implant design and techniques on practice and patient outcomes.

METHODS

This study represented a service evaluation; thus, ethical approval and informed consent were not required.

A consecutive series of patients of two upper limb surgeons was gathered at a single district general hospital with 424 beds serving a population of 300,000 between the years 2000 and 2019. Data were prospectively gathered by the treating physicians at follow-up clinic appointments.

Epidemiological data were gathered including age, sex, American Society of Anesthesiologists (ASA) score, occupation, and clinical diagnosis indicating surgery. Implant data were gathered for implant design, manufacturer, and the use of cementation of either the glenoid or humeral component. Patient outcome data were gathered for LOS, operative time, patient satisfaction VAS, pain VAS, OSS, Constant-Murley score (CMS) [10], range of movement (forward flexion, abduction, external rotation) using a goniometer, shoulder strength using a spring balance [11], complications, and implant survival.

Data were analyzed using SPSS statistics version 23.0 (IBM Corp.). Trends were analyzed using Spearman correlation for continuous data and chi-square test for categorical data. For analyses, 95% confidence intervals were used, and significance was set at $P = 0.05$.

All procedures were performed by fellowship-trained consultant surgeons or a specialty surgeon supervised by a consultant under general anesthesia with the patient in a beach chair position using a deltopectoral surgical approach and subscapularis tenotomy. The long head of the biceps tendon was tenotomised, and soft tissue tenodesis was performed before wound closure. The manufacturer's standard technique was used for the corresponding implant. The rotator cuff was repaired, and the wound was closed in layers. Postoperatively, the arm was supported in a sling. Pendular movements were started from the first postoperative day for all types of prosthesis, and the shoulder was mobilized with active assisted exercises from week 2 and active exercises after 6 weeks.

Patients were routinely followed in an upper limb outpatient clinic, with data collected at 2 weeks, 6 weeks, 12 months, and 60 months by the treating surgeon. Observation was ceased with rehabilitation had plateaued as evaluated by the physiotherapy team who independently assessed shoulder range of movement and collected patient-recorded outcome measures.

RESULTS

In total, 395 consecutive shoulder arthroplasties were performed (225 male, 170 female) after excluding 17 patients who died of causes unrelated to shoulder surgery and 75 who were lost to follow-up before the minimum 2 years of follow-up. The median follow-up period was 56 months (range, 24–180; interquartile range [IQR], 43).

Epidemiological Data

Median patient age was 73 years (range, 25–90; IQR, 13). There was no correlation of age with time ($P = 0.586$) or of sex with time ($P = 0.052$). The median ASA score was 3 (range, 1–4; IQR, 1) and did not correlate with time ($P = 0.244$). Of the patients, 344 were retired or not working, while 51 were employed; 32 had a manual occupation, and 19 had a non-manual occupation. All patients had returned to work by the most recent follow-up. Fig. 1 shows the indications for surgery: 58 cases were performed for trauma; 44 following a simple fall, 7 after a road traffic accident, and 7 due to falls while cycling. All were four-part fractures as per Neer's classification, 20 of which included dislocation [12]. The incidence of osteoarthritis (OA as the surgical indication increased over time, with a peak incidence in 2014 ($P < 0.001$).

Surgeon/Implant Choices

The number of cases by surgeon per year increased from three cases in 2,000 to a peak of 33 in 2011 (Fig. 2). The incidence of hemiarthroplasties declined after 2011 when more RTSR and anatomic TSR procedures were performed ($P < 0.001$) (Fig. 3). More glenoid (Fig. 4) and humeral components (Fig. 5) were cemented in later years ($P < 0.001$). More short-stem implants (Fig. 6) were used in later years ($P < 0.001$). Table 1 shows the frequency of use of implants by manufacturer each year. This peaked in 2011 (the mid-point of the study) when instruments from seven implant manufacturers were in use.

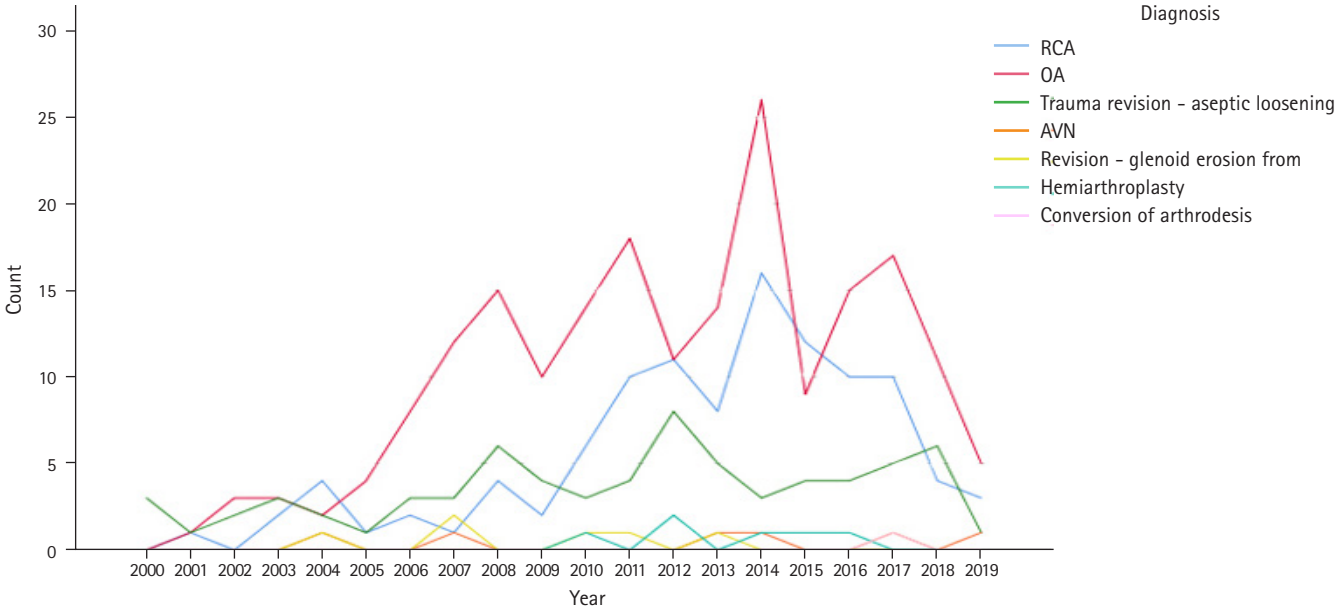

Fig. 1. Distribution of indication for surgery over time. RCA: rotator cuff arthropathy, OA: osteoarthritis, AVN: avascular necrosis.

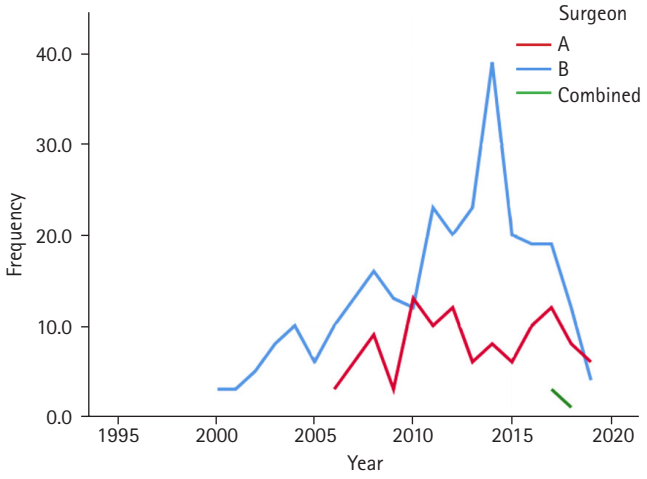

Fig. 2. The number of cases by surgeon per year.

Outcomes

The median LOS was 1 day (range, 0–38; IQR, 2), with moderate correlation (R = –0.411) for reduced LOS over time (P < 0.001) (Fig. 7). Median operative duration was 100 minutes (range, 31–195; IQR, 41), with a weak positive correlation (R = 0.165) for increased operating duration over time (P = 0.005) (Fig. 8). There was no difference (P = 0.735) using one-way analysis of variance. Median patient-rated satisfaction was 8 (range, 0–10; IQR, 2), with no correlation with time (P = 0.103). Median pain VAS score before surgery was 9 (range, 1–10; IQR, 1) and was weakly correlated (R = 0.176) with higher levels of preoperative pain over time (P < 0.001). Median pain VAS score after surgery was 3 (range, 0–6; IQR, 1), with no correlation (P = 0.554) with time.

Median preoperative OSS for pain was 3 (range, 0–20; IQR, 2) and moderately correlated (R = –0.336) with reduced pain over time (P < 0.001). Median OSS for pain postoperatively was 16 (range, 0–20; IQR, 6) and did not correlate with time (P = 0.785). Median OSS pain change (delta) was 12 (range, –8 to +20; IQR, 6) and had a weak positive correlation (R = 0.198, P < 0.001) with time. Median OSS preoperatively was 3 (range, 0–20; IQR, 2) with a weak negative correlation (R = –0.154) with time (P = 0.004). Median OSS postoperatively was 22 (range, 2–48; IQR, 9) and showed no correlation with time (P = 0.081). Median OSS change (delta) was +8 (range, –39 to +40; IQR, 16), with no correlation with time (P = 0.602). Median CMS was postoperatively 52 (range, 18–95; IQR, 20), with weak positive correlation (R = 0.228) for increase over time (P < 0.001). Postoperative median satisfaction VAS was 8 (range, 0–10; IQR, 2), with no correlation (P = 0.103).

For range of movement, forward flexion showed a median of 100° (range, 20°–180°; IQR, 36°), with weak positive correlation (R = 0.265) for increased forward flexion over time (P < 0.001). Median abduction was 90° (range, 20°–160°; IQR, 30), with weak positive correlation (R = 0.213) for increased abduction over time (P < 0.001). Median external rotation was 15° (range, –15° to +70°; IQR, 10°), with a weak positive correlation (R = 0.101) for increased external rotation over time (P < 0.045).

Complications

Fifteen shoulders underwent revision, and a further 60 cases was

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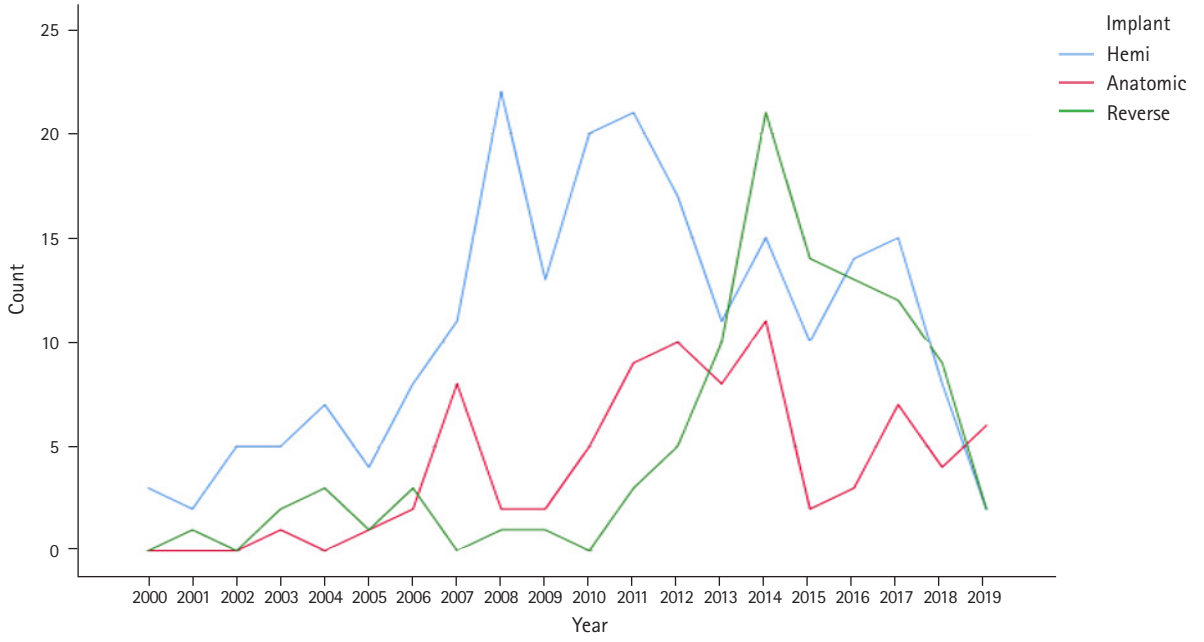

Fig. 3. Implant type frequency by year.

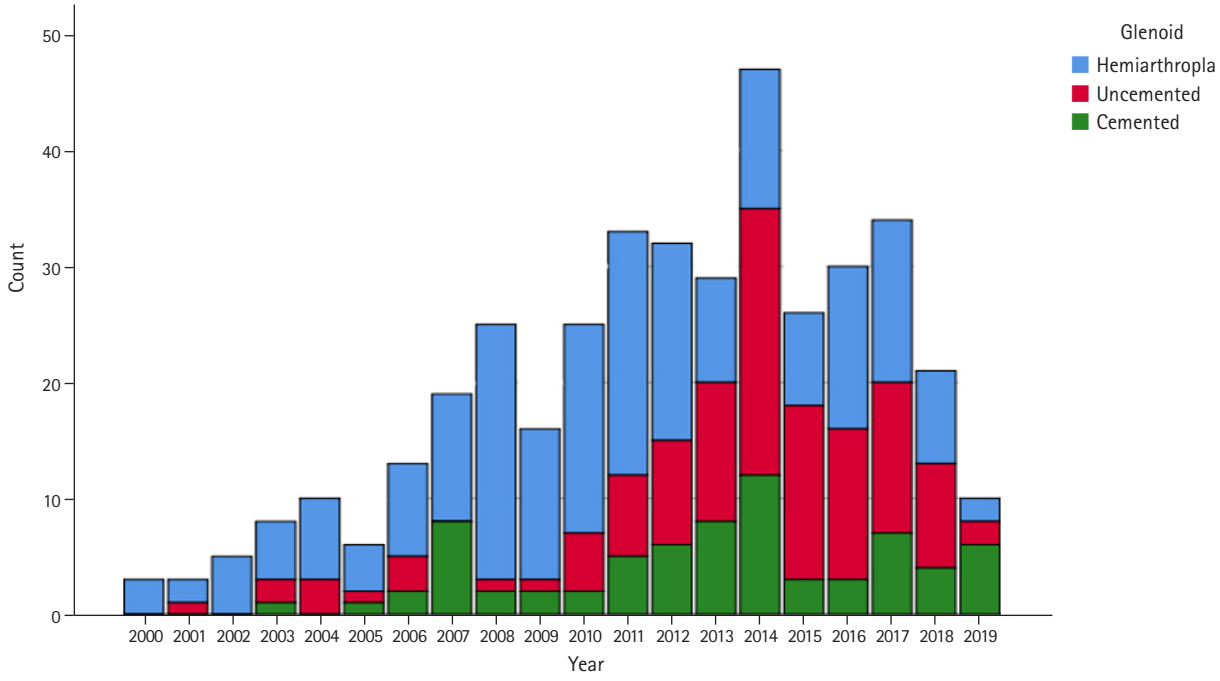

Fig. 4. Glenoid components by year.

offered revision (Fig. 9, Table 2). The revision cases were as follows: Aseptic loosening of anatomic TSR to RTSR (n=2); RTSR to hemiarthroplasty due to aseptic loosening (n=2); hemiarthroplasty revised due to glenoid erosion to RTSR (n=3) or to anatomic TSR (n=4); and Copeland resurfacing to stemmed hemiarthroplasty (n=2). One case of Copeland resurfacing underwent bone grafting to the glenoid for instability but did not require a change of implant. One anatomic short-stem TSR was revised for dislodgement of the head that had not engaged on the taper of the stem, identified on immediate postoperative imag-

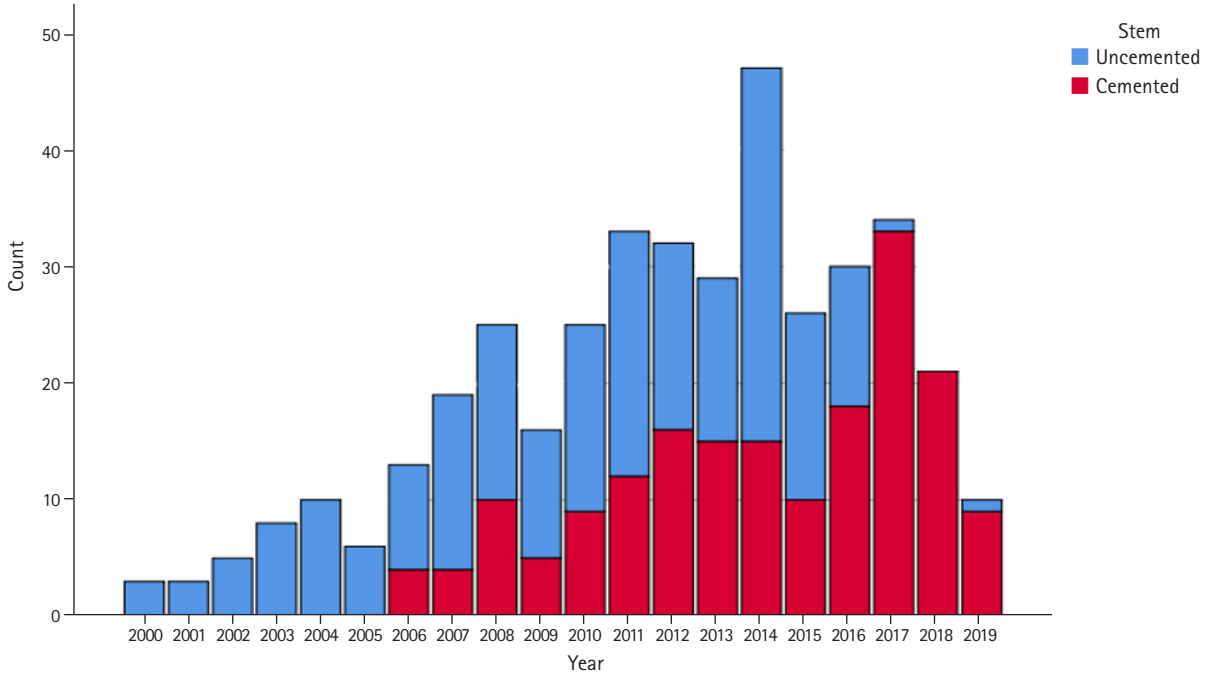

Fig. 5. Humeral components by year.

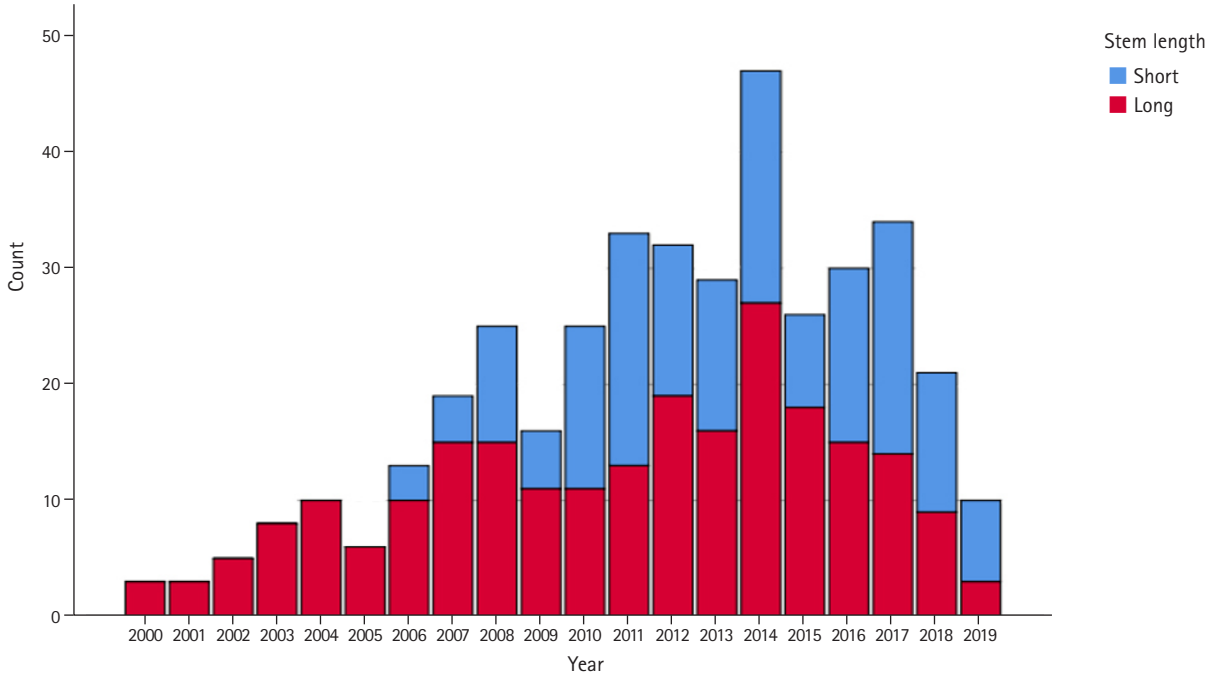

Fig. 6. Humeral stem length by year.

Table 1. Frequency of implant manufacturers used

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
No. of manufacturers	1	2	1	3	2	3	5	3	4	5	4	7	4	4	3	3	4	2	2	3	7

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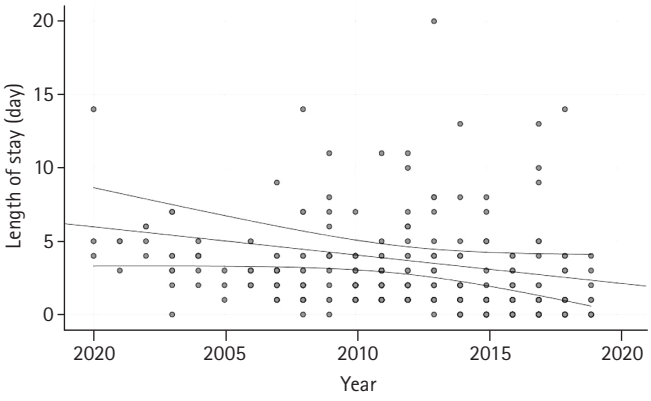

Fig. 7. Length of stay correlation with time.

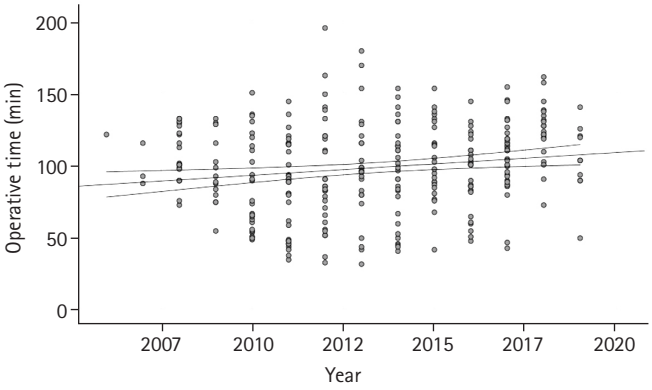

Fig. 8. Operative time correlation with time.

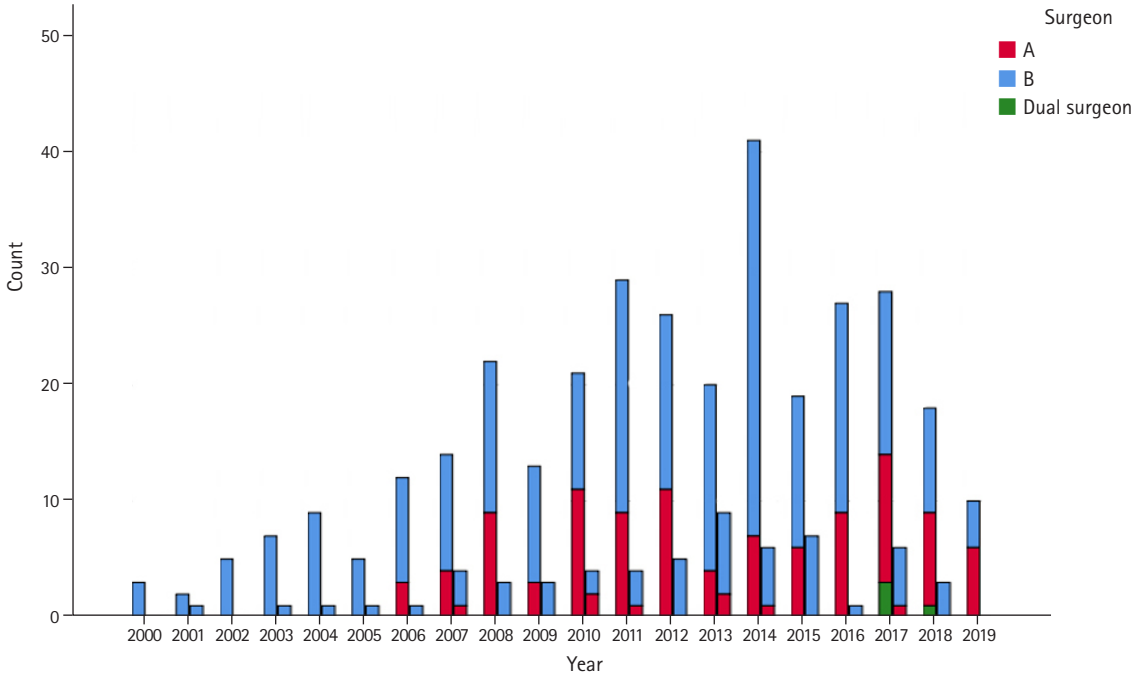

Fig. 9. Complications per year.

Table 2. Complications

Complication	Number
Infection (requiring return to theatre)	3
Superficial wound infection (not requiring return to theatre)	3
Rotator cuff failure	10
Fracture (postoperative sequalae of further trauma)	13
Loosening (radiographic evidence)	15
Nerve injury	2
Dislocation	4
Notching	8
Total	58

ing. One postoperative periprosthetic fracture of a traumatic reverse TSR was revised to a longer stemmed implant after a second fall at 3 years.

DISCUSSION

The aim of this study was to understand the impacts of increasing surgical volume and changes in practice over time on patient experience and outcomes. There were no trends for age, sex, or ASA over time. Of the total patients, 87% were retired or not working; of those employed, all returned to work. There was a trend for a surgical indication of OA and rotator cuff arthropa-

thy, with trauma numbers steady over time. This supports the development of implants better suited to manage rotator cuff arthropathy such as the reverse polarity prosthesis rather than older designs such as the resurfacing hemiarthroplasty, which have been proven to function poorer in rotator cuff-deficient shoulders [11]. A decline in surgery performance for causes other than trauma was seen in 2019, and was attributable to the coronavirus disease 2019 (COVID-19) pandemic.

Fewer hemiarthroplasties were performed after 2011, and reverse arthroplasty became significantly more common, along with anatomic TSR ($P < 0.001$). This was consistent with practice reported in the National Joint Registry of the United Kingdom [13]. The trend for increased use of cement in both glenoid and humeral components as well as increased use of short-stem implants reflects the increasing use of arthroplasty for trauma, where the standard of care is a cemented fracture stem, and the increasing use of anatomic implants over hemiarthroplasty and reverse arthroplasty, which preserve the glenoid or are fixed uncemented, respectively.

The number of implant manufacturers used each year gradually increased over the first 10 years, peaking at 7, and then decreased to 3. This was due to the availability of implants; for example, manufacturing shortage and the fluctuating availability of support from manufacturer representatives in the operating theatre. Surgeons tried several different companies before settling on those most effective in their experience. An attempt was made to use fewer implants to reduce variability and standardize treatment. Additionally, use of Copeland resurfacing hemiarthroplasty declined nationally and worldwide as it was found to be less effective for rotator cuff arthropathy [11] and was replaced with the more modern reverse geometry arthroplasty design.

For the first 4 years, fewer than 10 arthroplasties were performed per unit yearly. From 2004 onwards, 10 or more arthroplasties were performed, excluding 2005 when they numbered 6. Jain et al. [1] found higher mortality, longer LOS, and a higher number of complications in centers with surgeons performing four or fewer arthroplasties annually. The best outcomes were seen for centers with surgeons performing 10 or more arthroplasties annually [1]. Of the 19 cases performed in these early years, no patient died of causes related to hospital admission. This contrasts with the literature and may be explained by our small sample size. The LOS in patients operated in the first 4 years was a median of 5 days versus a median of 2 days in patients operated after the first 4 years. LOS significantly decreased over time from a median of 5 days to 1 day, indicating a trend towards daytime arthroplasty, which is now the standard of care in our unit. There was no significant change in operating time; this may reflect other processes such as choice of implant systems and manufacturer representative presence rather than the speed of the surgeon. Complications occurred in two of these early cases (11%) and included one case of aseptic loosening and one fracture (sequelae of further trauma; there were no intraoperative fractures).

Patients were consistently satisfied; with a satisfaction score of 8/10 and pain VAS that consistently improved from 9/10 preoperatively to 3/10 postoperatively. Preoperative OSS decreased slightly over time, suggesting a poorer starting point; however, this showed a weak correlation. OSS for pain and total OSS also improved from preoperative score, with mean improvement of 8, which is above the 6.6 threshold for minimally important clinical difference [14]. Median CMS was 52, similar to other recent studies with scores of 58 ± 19 for reverse arthroplasty. Ernstbrunner et al. [15] reported in 2019, an improvement of 29 to 59 at minimum 5 year in a review of 8 studies including 365 shoulders. CMS trended towards an improvement from a median of 50 in the first 5 years to 60 in the most recent 5 years, a clinically detectable difference [14], although this did not reach significance.

For range of movement, median forward flexion was 100° (range, 20°–180°; IQR, 36°), with weak positive correlation ($R = 0.265$) for increased forward flexion over time ($P < 0.001$). Abduction showed a median of 90° (range, 20°–160°; IQR, 30°) with weak positive correlation ($R = 0.213$) for increased abduction over time ($P < 0.001$). Median external rotation was 15° (range, –15° to +70°; IQR, 10°), with a weak positive correlation ($R = 0.101$) for increased external rotation over time ($P < 0.045$). These results are similar to those of other patient series compared to the results of Ernstbrunner et al. [15] (forward flexion 127°, abduction 113°, and external rotation 24°). Overall postoperative patient-recorded outcome measures and range of movement did not significantly vary over the study period, with only weak correlation demonstrated. This demonstrates little perceived difference in the benefit of different surgical techniques despite the evolution in treatments provided, although LOS decreased steadily with a trend towards daytime surgery, which is now the standard in our unit.

Complication rates increased in relation to the volume of procedures performed. Only three deep infections were seen and were treated operatively with debridement and retention of implant. No deep infections required revision of components. There were 10 cases of anatomic prosthesis rotator cuff failure; these required revision to a reverse TSR. Of the 15 cases with aseptic loosening, 4 required revision. Although 13 shoulders were revised and a further 60 cases were offered revision, the majority of these was for glenoid erosion in Copeland hemiarthroplasty,

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which is no longer used. There were two cases of nerve injury; however, these resolved spontaneously and were thought to be related to the regional nerve block.

This study was limited by its retrospective nature, having relatively small patient numbers and a heterogenic group of patients receiving different treatments. It is an observational study over a long time period, reporting the experience in a small resource-limited district general hospital. The patient experience was similar over the study period despite the evolving treatments provided.

CONCLUSIONS

We believe it is essential to continue to provide evidence-based best treatment and to audit local outcomes against national registries and case series reported in the literature and to monitor patient outcomes for safety. Despite frequent introductions of new implants with evolving technology, supply issues, or changing surgeon preference, patient outcomes remained good. Further studies looking at the impact of frequent implant changes are recommended to further understand the learning curve required to ensure optimum surgical performance with changing trends in treatment. There is a need for large-scale, generalizable studies to understand why technological advancements leading to changes in implants do not influence clinical outcomes.

NOTES

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Author contributions

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Conflict of interest

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Data availability

Contact the corresponding author for data availability.

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