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PRECIS

A database study of 5,857 primary retinal detachment operations found no difference in failure rate between surgeon grades.

Royal College of Ophthalmologists' National Ophthalmology Database Study of Vitreoretinal Surgery: Report 7, Inter-surgeon Variations in Primary Rhegmatogenous Retinal Detachment Failure Rates

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Conflict of Interest: R.L. Johnston is the Medical Director of Medisoft Limited, which developed the commercially available electronic medical record from which anonymised vitreoretinal data were extracted from 15 sites and T.H. Williamson developed the non-commercial VITREOR EMR database from which data were extracted from 3 sites to the National Ophthalmology Database for this study.

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Running head: Inter-surgeon variation in primary RRD failure rate

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ABSTRACT

Purpose: To audit variations in primary rhegmatogenous retinal detachment (RD) anatomical failure rates between surgeons, grades of surgeon and technique of RD surgery.

Design: Retrospective national clinical database study

Participants: A total of 5,857 eyes undergoing primary RD surgery.

Methods: Clinical data from 2000-2013 were retrospectively extracted from 15 centres using the same commercially available electronic medical record (EMR) system, from 3 vitreoretinal units using an in-house EMR and from the British and Eire Association of Vitreoretinal Surgeons (BEAVRS) online registry.

Results: The 5,857 primary RD operations were performed by 117 surgeons: 3,349 (57.2%) by consultants, 520 (8.9%) by independent non-consultants and 1,988 (33.9%) by trainees. Surgery comprised pars plana vitrectomy (PPV) for 4,666 (79.7%) operations, scleral buckle (SB) for 815 (13.9%) and PPV + SB for 376 (6.4%). The RD re-operation rate at 6 months after primary surgery was 13.9% (725/5,202), and did not differ significantly between consultants and trainees ($p = 0.382$). For surgeons contributing ≥ 50 cases, the mean (range) reoperation rates were 13.1% (6.7% – 26.8%), 15.1% (11.3% - 18.2%) and 15.3% (9.4% - 22.1%) for consultant, independent non-consultant and trainee surgeons, respectively. The SB failure rate was not significantly different from PPV ($p = 0.095$).

Conclusion: The grade of surgeons and the technique of surgery were not associated with a significant difference in primary RD failure rates.

INTRODUCTION

Rhegmatogenous retinal detachment (RD) surgery is the most common indication for vitreoretinal surgery.¹ Pars plana vitrectomy (PPV) and scleral buckle (SB) are the most frequently used techniques,¹⁻⁵ with the proportion of patients undergoing PPV in the United States increasing to approximately three-quarters over the last decade.⁴ Whilst the functional outcome of RD is probably of the greatest importance to patients, the primary anatomical re-attachment rate is the most commonly reported surgical outcome, and is regularly used to benchmark surgical skill and the quality of care.⁶

There has been recent interest in physician-level outcomes being visible to the public in Europe and North America among different specialities, including ophthalmology.^{7,8} The primary objective is to create a tool that will drive service improvement and improve patient safety. Physicians will be able to benchmark their performance, reflect on their practice and increase their accountability to the public who may be able to confirm whether a particular individual is performing within acceptable boundaries. Furthermore, physician-level outcomes are becoming important for healthcare commissioners and certification bodies. In the United States, reimbursement is currently linked to providing information on certain quality indicators to insurance companies. In the United Kingdom (UK), physicians are required to have their license to practice renewed every 5 years. The Royal College of Ophthalmologists has recommended primary RD success rate as one of the benchmark indicators for fitness to practise vitreoretinal surgery, although to date no acceptable boundaries for case mix adjusted RD success rates have been

defined.⁹ Several studies have documented the success rate of primary RD surgery¹⁰⁻²⁰ but few have analysed inter-surgeon variation and those that did included only experienced surgeons¹⁶ or a few centres reporting only one technique: PPV.¹⁷⁻¹⁹

The UK National Health Service (NHS) provides an ideal environment for “real-world” studies of vitreoretinal surgery outcomes. The NHS serves over 95% of the UK population undergoing vitreoretinal surgery and employs a large number of vitreoretinal surgeon specialists, including trainees. Widespread adoption of electronic medical record systems (EMR) and surgical subspecialty registries allow prospective collection of detailed datasets.^{5, 21} The purpose of this study was to describe variations in primary anatomical failure rates between and within each grade of surgeon, and the influence of surgical technique, using a large set of data from the UK.

METHODS

Data recording and extraction

This database study reports results of primary RD surgery from three sources of data collected within the UK and supplied to The Royal College of Ophthalmologists’ National Ophthalmology Database (RCOphth NOD). Data were extracted from 15 vitreoretinal units that used the same ophthalmology EMR system (Medisoft Ophthalmology, Medisoft Limited, Leeds, UK) up to November 2010, from three vitreoretinal units using an in-house non-commercial vitreoretinal EMR (VITREOR database, Guy’s and St. Thomas’ NHS Foundation Trust, London, UK) up to October 2013 and from 24 surgeons using the British and Eire Association of Vitreoretinal Surgeons’ (BEAVRS) primary retinal detachment online registry (BEAVRS registry) up

to April 2014. The lead clinician and Caldicott Guardian (who oversees data protection) at each hospital gave written approval for anonymised EMR data extraction. Anonymized database analyses of this type do not require ethical permission as they are viewed as audit/service evaluation, in line with UK guidance.²² This study was conducted in accordance with the declaration of Helsinki, and the UK's Data Protection Act.

Inclusion and Exclusion Criteria

Eligible RD operations were primary operations for RD but excluding RDs due to penetrating eye injury or severe blunt trauma, vasoproliferative disorders or inflammatory eye disease. Eyes that underwent pneumatic retinopexy were also excluded from this study because this technique is performed in only a very small proportion of cases in the UK¹³ and the numbers were too small to allow meaningful analysis of inter-surgeon variation. Operations recorded on the BEAVRS registry with an 'unknown' outcome were also excluded, as were operations (from all sources) performed within 6 months of data extraction, to allow sufficient time for follow up given that 97.5% of primary failures occur within the first 6 months and therefore a shorter duration of follow-up can under-estimate surgeons' failure rates.²⁰

Statistical methods

Eligible RD operation surgical techniques were categorised as pars plana vitrectomy (PPV), scleral buckle (SB), or PPV plus scleral buckle (PPV + SB). The grade of surgeon was categorised as consultant surgeon, independent non-consultant surgeon (middle grade specialized retina surgeon) and trainee surgeon (fellow and specialist registrars).

All per year results use the UK NHS year, which runs from 01 April to 31 March except for operations performed prior to the 2003 NHS year that were grouped together due to the very small number of operations.

The data from the EMRs included data for all vitreoretinal operations performed in an eye and primary RD failure for the operations recorded on these systems was defined as a subsequent operation for RD within 6 months of primary RD surgery. Operations with no record of repeat RD surgery within 6 months of primary surgery were classified as success. Subsequent laser or cryopexy treatments without the use of intraocular tamponade were not considered as retinal re-attachment procedures. For the primary RD operations recorded on the BEAVRS registry the surgeon reports the outcome of the operation as 'success or failure' at least 2 months postoperatively and the date of any subsequent failure if it occurs. Using data from the EMRs only, it was possible to calculate an additional secondary estimate of primary RD failure, which counted operations where silicone oil was used at the primary surgery as failures if the oil was still in situ at 6-month time point.

Individual surgeon variation in failure rates was explored through the use of a funnel plot. No confidence, or 'control' limits were applied, as these are crude failure rates that have not been adjusted for case mix complexity. Potential differences in primary failure between surgical techniques and surgeon grades were investigated using univariate logistic regression where the individual surgeons were fitted as clusters. Separate regressions for surgeon grade, surgical technique and surgical technique within each surgeon grade were performed.

Time to RD re-operation was investigated using the Kaplan-Meier method where a second RD operation was the event. Eyes were censored at their last follow up if not experiencing the event and all eyes were censored at 5 years from primary RD surgery. All analysis was conducted using STATA version 11 (StataCorp, College Station, TX).

RESULTS

Study Sample and Patient Demographics

From 7,534 RD operations recorded during the study period, 6,438 were for primary RD. Of these, 581 primary RD operations were excluded: 86 as they were treated with pneumatic retinopexy, 349 as they had a follow up time of less than 6 months and 146 as they had an 'unknown' outcome on the BEAVRS registry, leaving 5,857 primary RD operations from 5,729 patients eligible for analysis. Left eyes were operated on in 2,761 cases; right eyes in 3,096 cases and 128 patients had RD surgery in both eyes.

The primary RD operations were performed by 117 surgeons, 72 of whom recorded 3,056 operations on the commercial EMR, 21 surgeons recorded 1,645 operations on the non-commercial EMR from a total of 18 UK vitreoretinal units and 24 surgeons recorded 1,156 operations on the online BEAVRS registry. The median number of operations performed by each surgeon was 131 (range: 1 - 514).

Of the 5,729 patients, 3,441 (60.1%) were male, 2,282 (39.8%) female and the gender was not specified for 6 (0.1%) patients. Ethnicity data were not recorded for 3,067 (53.5%) patients. From the 2,662 patients whose ethnicity was recorded, 2,510

(94.3%) were Caucasian and 152 (5.7%) were from other ethnic groups (2.3% Afro-Caribbean, 1.8% Asian, 0.6% Mixed race and 1.1% other ethnicity). The median age of the patients at the time of primary RD surgery was 60.3 years (range: 0.4 - 97.2 years). The median age was lower for SB surgery than either PPV or PPV + SB surgery (medians; 39.3 vs 62.1 and 60.8 years, respectively).

Primary retinal detachment surgery

Primary RD surgery was performed using PPV in 4,666 (79.7%) cases, SB in 815 (13.9%) cases and PPV + SB in 376 (6.4%) cases. Of the 5,042 primary RD operations that included a PPV (PPV and PPV + SB), silicone oil was used in 1,070 operations (21.2%). Consultant surgeons used silicone oil in 19.8% of operations that included a PPV whilst trainees used it in 24.5% of cases, Table 1.

Fifty-six consultant surgeons performed 3,349 (57.2%) operations, 18 independent non-consultant surgeons performed 520 (8.9%) operations, 48 trainee surgeons performed 1,988 (33.9%) operations and 5 surgeons performed operations at more than 1 grade due to career progression over the study period. Figure 1 shows the percentage of primary RD surgery by operative technique recorded per year; the percentage of primary RD operations using PPV in each NHS year increased from 68.6% before 2003 NHS year to 85.3% in the 2013 NHS year.

Primary RD surgery failure rate

For this study, the primary estimate of failure was repeat surgery or a surgeon's record of failure within 6 months of surgery. From the 5,857 primary RD operations,

655 (11.2%) were excluded from the primary estimate of failure analysis as they had silicone oil in situ.

Primary RD surgery was deemed as failure in 725 (13.9%) operations (583 repeat RD operations and 142 recorded as failures on the BEAVRS registry), and a success in 4,477 (86.1%) operations. The primary failure rates were not statistically different between the 3 sources of data: 14.8% (393/2,655) for the commercial EMR, 13.7% (190/1,391) for the non-commercial EMR and 12.3% (142/1,156) for the BEAVRS registry ($p = 0.112$).

Figure 2 depicts a Kaplan-Meier failure graph of time to repeat RD surgery for each type of primary RD surgery technique for 3,721 operations, excluding data from the BEAVRS online registry where the date of repeat RD surgery is not recorded. Of the 667 repeat operations performed within a follow up time of 5 years, the median time to re-operation was of 1.7 months (range: 1 day - 7.3 years) and 583 (87.4 %) were operated within the first 6 months.

From the 4,701 primary RD operations recorded on the EMRs, a secondary estimate of failure was calculated, which includes counting silicone oil in situ at 6 months as failure. Of 4,701 eligible operations (4,573 patients) primary RD surgery failed in 1,238 (26.3%) operations (583 repeat operations and 655 eyes with no repeat surgery, but silicone oil in situ at 6 months).

Inter-surgeon variation in failure rates

The failure rates did not differ statistically between the grade of surgeon, Table 2 and the mean failure rates per grade of surgeon were 13.4%, 15.0% and 14.6% for

consultant surgeons, independent non-consultant surgeons and trainee surgeons, respectively. For surgeons who had performed ≥ 50 operations at a particular grade, the mean (range) failure rates were 13.1% (6.7% - 26.8%) from 20 consultant surgeons, 15.1% (11.3% - 18.2%) from 3 independent non-consultant surgeons and 15.3% (9.4% - 22.1%) from 12 trainee surgeons. The mean failure rates if silicone oil in situ counts as failure were 26.8%, 23.8% and 26.5% from 32 consultant surgeons, 18 independent non-consultant surgeons and 48 trainee surgeons, respectively.

Figure 3 is a funnel plot of the percentage of primary RD failure vs. the number of operations performed by each surgeon. The horizontal line is the overall mean failure rate using the primary estimate of failure. For surgeons who contributed more than 50 primary RD operations the spread around this line on the funnel plot, which represents the variation in failure rate between individual surgeons, does not narrow substantially with increasing surgical volume, implying that very high volume may not be associated with lower RD failure.

Failure rate by technique of surgery

The primary failure rates were 14.0%, 11.3% and 21.6% for PPV, SB and PPV + SB surgery respectively. The failure rates of PPV versus SB were not significantly different, but PPV + SB was significantly higher than both (odds ratio with respect to PPV surgery= 1.70, 95% CI: 1.09 to 2.63, $p = 0.018$), Table 2.

DISCUSSION

This large UK national database study examined variation in the primary anatomical failure rate of RD surgery within and between grades of surgeon, over a thirteen-year period. It pooled data on 5,857 primary retinal detachment operations, performed by 117 surgeons from a large number of centres geographically spread across the UK. In a real-world setting where vitreoretinal surgeons have the freedom to choose the surgical technique for a particular clinical situation, we found no difference in primary RD surgery failure between vitreoretinal consultants and trainees. Additionally, our results also suggest that variations in failure rates are not marked between individual surgeons and that unlike other types of surgery failure rates are not lower in surgeons who perform the highest volume of surgery.

Our data show a primary anatomical failure rate at 6 months post-surgery of 13.9% based on a record of repeat RD surgery or a record of failure. If the definition of failure is extended to include cases with silicone oil in situ, the overall failure rate increases to 26.3%. Significant variation in reported primary RD failure exists.¹⁰⁻¹⁹ This range may be due to variations in patient selection including surgical complexity, the definition of primary RD failure, the timeframe for reporting failure, and the inclusion or exclusion of cases with silicone oil in situ. A recent nationwide database study from Denmark found a 22% re-operation rate after RD surgery, using a large subset of 6,522 eyes of which 29.5% received silicone oil injection.¹⁵ Data from a European randomized controlled trial of SB and Primary PPV in RD¹⁰ that had restricted entry criteria and considered any postoperative retinopexy procedure even without the use of tamponade or subsequent macular pucker surgery as a

failure, reported a primary mean failure rate of 36.8%. However, a more recent retrospective case-note review study¹⁴ using similar retinal surgery techniques but with less strict criteria for defining primary failure, reported a substantially lower failure rate of 14.7%.

Possible explanations for variation in surgical failure rates between individual surgeons could be differing levels of experience, surgical skill, case-mix complexity and the number of operations performed each year. There is a growing consensus that funnel plots are the method of choice for institutional and inter-individual comparison.²³ In our study, the funnel plot was chosen to display a visual comparison of individual surgeons' failure rates (Figure 3). Unexpectedly, for surgeons who contributed 50 primary RRD operations or more, there was little evidence that increased surgical volume leads to better anatomic results. This differs to other branches of surgery for example cataract surgery, where increased volume is associated with reduced complication rates.¹² It is possible that a greater influence of surgical success than surgical volume is disease biology, at least in countries such as the UK where all surgery is performed or supervised by specialized retinal surgeons. The spread of results on the funnel plot widens as the number of cases decreases, especially in those with less than 50 cases. However, this effect may well be because of sampling error and does not necessarily imply that lower volume surgeons have less predictable results. When interpreting results from lower volume surgeons, caution is advisable due to the problems associated with small sample sizes.

No differences in primary RD failure rates were found between surgeon grades. Trainee surgeons had a similar failure rate to consultants, and this is reassuring for both clinicians and patients. This may suggest that the lack of experience of trainee surgeons is compensated for by supervision from consultants or is accounted for by junior surgeons treating fewer complex cases.

Few studies have assessed inter-surgeon success rates for primary RD surgery. Heimann et al¹⁶ reported a study of 681 eyes that were randomized to either PPV or SB, with surgery undertaken by 45 highly experienced surgeons. The primary anatomical failure rate varied between surgeons from 10.0% to 58.3%. Whereas our study included different grades of surgeons, those in Heimann et al's were all retinal specialists who had previously performed at least 100 PPV procedures and a similar number of SBs. Another important difference is that our data were collected as a part of routine clinical care, where surgeons had the freedom to choose the technique of surgery, whereas those reported by Heimann et al were randomized to a particular technique. While a randomised study may better answer the question of which surgical technique is most effective to treat retinal detachment, it may be less representative of routine care than a large database study, and less suitable for benchmarking as vitreoretinal surgeons differ with respect to their indications and preferences for SB versus PPV surgery. In fact its results may be biased if surgeons are forced to adopt surgical techniques that was not their preferred option.

Three other studies have reported on inter-surgeon variation in primary RD failure rates, but only in relation to primary PPV.¹⁷⁻¹⁹ The results were similar to this study in showing that primary RD failure rates of less experienced surgeons were similar to

those of more senior surgeons. One of these studies that comprised 512 patients with RD from one vitreoretinal centre showed that less experienced surgeons who had previously performed fewer than 30 PPVs independently prior to commencing the study had better outcomes than more experienced specialists.¹⁹ The authors speculated that this may have been due to case selection or the more frequent use of non-contact wide-angle viewing systems compared to more senior surgeons who used conventional contact lenses.¹⁹

Similar to the grade of surgeon, the choice of scleral buckle vs. PPV did not significantly influence the primary anatomical success rate. In the UK, PPV surgery is currently the dominant technique used to treat RD and SB is increasingly reserved for non-complex RD in the absence of posterior vitreous separation in young patients.¹³ In contrast to PPV or SB, combined PPV + SB surgery had the highest rates of failure for all grades of surgeon in our series. Although the number of these cases is relatively small making it difficult to draw firm conclusions, case selection is likely to explain the higher failure rate in this group as this technique is disproportionately used to treat more complex cases.

As with other database studies, this study has limitations. Firstly, to be inclusive of all possible surgeon outcomes, we pooled data from 3 UK sources and this meant we had to use two different definitions for primary surgical failure. Whilst this may have introduced some heterogeneity to the results, we expect that this limitation would not change the significance of failure for each surgeon grade, as bias should apply across all surgeon groups and it is reassuring that the overall failure rate from each data source was similar. Secondly, as with previous studies,^{3, 15, 24} we used the

absence of further RD surgery recorded on the EMRs as the indicator of success but some cases may have re-detached and the patient chose to decline a second operation or may have attended another center for repeat surgery. As untreated recurrent RD is associated with a high risk of serious visual impairment,³ we expect the overwhelming majority of patients elect to undergo repeat RD surgery and furthermore most contributing centres are the only providers of vitreoretinal surgery to their local communities. Thirdly, The BEAVRS RD online registry had a significant number of cases with missing outcomes of surgery that were excluded from the study, which may itself be a source of bias. Finally, the data in this study cannot determine whether any individual's failure rate falls outside acceptable boundaries as we were not able to account for case-mix complexity (such as extent of RD, proliferative vitreoretinopathy grade, number or position of breaks, etc). Such analyses will be possible in the future as The Royal College of Ophthalmologists in the UK has ratified a nationally agreed RD dataset that is now collected consistently at all sites.

To our knowledge this is the largest study in the literature reporting on surgeon level outcome in primary retinal detachment surgery. An additional strength of the study is that the data were prospectively collected as a by-product of routine care from multiple centres, non-selective and pragmatic and so are likely to be more generalizable than those obtained from single centres, small case series or retrospective case note reviews, which may suffer from publication bias, where clinicians may be reluctant to publish unfavorable outcomes.²⁵

In summary, this primary RD study is the largest to specifically investigate variations in primary anatomical failure rate between individual surgeons and grades of surgeon. The overall failure rate was found to be similar across differing grades of surgeon, suggesting appropriate case selection and supervision of trainee surgeons. Our results provide surgeons with data against which they can benchmark their surgical failure rates, but case-mix needs also to be considered. This may assist with re-certification of vitreoretinal surgeons and help inform the consent process prior to RD surgery, particularly when surgery is to be undertaken by surgeons in-training. As has been the case for posterior capsular rupture during cataract surgery,²⁶ future work will develop a methodology for case-mix adjustment, but unlike cataract surgery, primary RD failure rates do not appear to decrease markedly with increasing surgical volume.

FIGURE LEGENDS

Figure 1: Percentage of primary retinal detachment operations by operative technique recorded per National Health Service (NHS) year. Operations recorded from 2000-2003 NHS year were combined due to the relatively small number of operations recorded in each of these years. N = the number of operations, S = the number of surgeons.

Figure 2: A Kaplan-Meier failure graph of time to repeat retinal detachment (RD) surgery for each type of primary RD surgery technique for 3,721 operations performed by 83 surgeons. All follow up time was censored at 5 years after primary RD surgery (there was 1 PPV no SB eye that underwent repeat RD surgery after 5 years).

Figure 3: A funnel plot of primary retinal detachment failure within 6 months of surgery for 116 surgeons who performed 5,202 operations, 5 of whom have data for more than one grade. Data from all 3 contributing sources was used. Different symbols are used for each grade of surgeon and the X-axis displays the number of operations recorded.

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Table 1: Primary retinal detachment surgery details

Primary retinal detachment operation. N (column %)	Consultant surgeons (N = 3,349)	Independent non-consultant surgeons (N = 520)	Trainee surgeons (N = 1,988)	Total (N = 5,857)
Number of surgeons*	56	18	48	122
Surgery classification				
PPV	2,696 (80.5)	378 (72.7)	1,592 (80.1)	4,666 (79.7)
SB	414 (12.4)	103 (19.8)	298 (15.0)	815 (13.9)
PPV + SB	239 (7.1)	39 (7.5)	98 (4.9)	376 (6.4)
Silicone oil used (when PPV included in operation)				
Yes	582 (19.8)	74 (17.7)	414 (24.5)	1,070 (21.2)
No	2,353 (80.2)	343 (82.3)	1,276 (75.5)	3,972 (78.8)

*5 surgeons have data recorded for more than 1 grade.

PPV = pars plana vitrectomy; SB = scleral buckle; PPV + SB = pars plana vitrectomy with additional scleral buckle.

Table 2: Primary retinal detachment failure (excluding eyes without repeat RD surgery but with silicone oil in situ at 6 months)

	n	N (failures)	Failure rate (%)	Odds ratio	95% CI	P-value
Overall	5,202	725	13.9	N/A	N/A	N/A
Surgeon grade*						
Consultant surgeons	3,025	406	13.4	Reference	N/A	N/A
Independent non-consultant surgeons	466	70	15.0	1.14	0.80 to 1.62	0.465
Trainee surgeons	1,711	249	14.6	1.10	0.89 to 1.36	0.382
Surgical technique						
PPV	4,125	576	14.0	Reference	N/A	N/A
SB	813	92	11.3	0.79	0.59 to 1.04	0.095
PPV + SB	264	57	21.6	1.70	1.09 to 2.63	0.018
Grade of surgeon and operative technique						
Consultant surgeons						
PPV	2,441	341	14.0	Reference	N/A	N/A
SB	414	40	9.7	0.66	0.47 to 0.92	0.015
PPV + SB	170	25	14.3	1.06	0.57 to 1.98	0.850
Independent non-consultant surgeons						
PPV	337	47	13.9	Reference	N/A	N/A
SB	101	14	13.9	0.99	0.73 to 1.35	0.964
PPV + SB	28	9	32.1	2.92	1.87 to 4.56	0.000
Trainee surgeons						
PPV	1,347	188	14.0	Reference	N/A	N/A
SB	298	38	12.8	0.90	0.50 to 1.62	0.727
PPV + SB	66	23	34.8	3.30	1.69 to 6.43	0.000

*5 surgeons have data recorded for more than 1 grade.

CI = Confidence Interval; N/A = not applicable; PPV = pars plana vitrectomy; SB = scleral buckle; PPV + SB = pars plana vitrectomy with additional scleral buckle

Figure 1

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Figure 2
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Figure 3

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