Advances in medical technology over the last 2 decades have enabled patients with an unruptured intracranial aneurysm (uIA) to have greater choice in its management. Previously, the only therapeutic option was surgical clipping, but there is an increasing trend for endovascular interventions. When faced with the choice between treatment and no treatment of a uIA, patients seek information about the impact of each option on their survival, ability to function, and subsequent quality of life (QOL). The main reason for having a uIA treated is

Functional outcomes and quality of life after microsurgical clipping of unruptured intracranial aneurysms: a prospective cohort study

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OBJECTIVE Few studies have examined patients’ ability to drive and quality of life (QOL) after microsurgical repair for unruptured intracranial aneurysms (uIAs). However, without a strong evidentiary basis, jurisdictional road transport authorities have recommended driving restrictions following brain surgery. In the present study, authors examined the outcomes of the microsurgical repair of uIAs by measuring patients’ perceived QOL and cognitive abilities related to driving.

METHODS Between January 2011 and January 2016, patients with a new diagnosis of uIA were prospectively enrolled in this study. Assessments were performed at referral, before surgery, and at 6 weeks and 12 months after surgery in those undergoing microsurgical repair and at referral and at 12 months in conservatively managed patients. Assessments included the Physical Component Summary (PCS) and Mental Component Summary (MCS) of the SF-36, the off-road driver-screening instrument DriveSafe (DS), the modified Barthel Index (mBI), and the modified Rankin Scale (mRS).

RESULTS One hundred sixty-nine patients were enrolled in and completed the study, and 112 (66%) of them had microsurgical repair of their aneurysm. In the microsurgical group, there was a trend for improved DS scores: from a mean (± standard deviation) score of 108 ± 10.7 before surgery to 111 ± 9.7 at 6 weeks after surgery to 112 ± 10.2 at 12 months after surgery (p = 0.05). Two percent of the microsurgical repair group and 4% of the conservatively managed group whose initial scores indicated competency to drive according to the DS test subsequently had 12-month scores deemed as not competent to drive; the difference between these 2 groups was not statistically significant (p > 0.99). Factors associated with a decline in the DS score among those who had a license at the time of initial assessment were an increasing age (p < 0.01) and mRS score > 0 at one of the assessments (initial, 6 weeks, or 12 months; p < 0.01).

Mean PCS scores in the microsurgical repair group were 52 ± 8.1, 46 ± 6.8, and 52 ± 7.1 at the initial, 6-week, and 12-month assessments, respectively (p < 0.01). These values represented a significant decline in the mean PCS score at 6 weeks that recovered by 12 months (p < 0.01). There were no significant changes in the MCS, mBI, or mRS scores in the surgical group.

CONCLUSIONS Overall, QOL at 12 months for the microsurgical repair group had not decreased and was comparable to that in the conservatively managed group. Furthermore, as assessed by the DS test, the majority of patients were not affected in their ability to drive.

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KEY WORDS function; aneurysm; surgery; quality of life; vascular disorders
to prevent the risk of rupture, which could lead to death, disability, and a reduced QOL. Patients are reticent to proceed with surgical treatment if there is a high risk that it will leave them unable to return to their normal environment and occupations.

Some studies have questioned the effectiveness of surgical treatment for uIAs given the potential for poor cognitive outcomes; however, these oft-cited studies did not conduct pretreatment cognitive assessments. It is not known if the poor cognitive outcomes were attributable to the surgical procedure or had been present before the operation. Other studies have examined patient function and QOL before treatment and after treatment to determine if there is any change. However, these studies have limitations in terms of low patient numbers or poor participant compliance. And still other studies have relied on retrospective ratings of patient function pretreatment.

For many, the ability to return to their typical occupations, such as caring for family, employment, and participation in the community, is related to their ability to drive a motor vehicle. Restrictions are appropriate when either neurological deficits or seizures can reduce a patient’s ability to drive safely. The determination for a safe return to driving is usually the responsibility of the treating clinician. Some jurisdictional authorities (for example, Australia, New Zealand, United Kingdom, Ireland, Canada, Norway, Switzerland, and Hong Kong) have deemed this decision of sufficient importance to introduce recommendations about the timing of driving resumption after microsurgery for uIAs for at least some driver’s license classes. For those countries and states without such recommendations, most of the responsibility falls to the physician (who may recommend independent testing) and the patient. An error in judgment in declaring competence may have unanticipated ramifications. However, there are very limited data specific to driving competency following microsurgical repair of uIAs on which this decision can be confidently made. In the absence of evidence, recommendations may be inappropriate or unenforced. Therefore, improving the basis on which such recommendations can be made is important.

DriveSafe DriveAware is a recently introduced tool for examining and predicting a person’s cognitive ability associated with a competent driving performance. The DriveSafe (DS) component of DriveSafe DriveAware is an off-road test that measures a driver’s awareness of the driving environment. The original version of DS has been found to have excellent sensitivity (93%) and specificity (96%) for predicting on-road driving performance. A DS score > 95 is consistent with competent driving performance. The DS score along with other factors, such as the risk of seizures, visual field defects, and disability, can be considered in assessing a patient’s fitness to drive.

In this study we examined the impact of surgery for uIA on patients’ QOL and DS score by performing assessments both before and after surgery.

**Methods**

**Participants**

The study was approved by the Macquarie University Human Ethics Committee and complied with the requirements set out in the Australian National Statement on Ethical Conduct in Human Research.

The study was conducted from January 2011 to January 2016. All patients with a recently diagnosed uIA who were referred to the neurosurgery team at Macquarie University were eligible for enrollment. For the microsurgical repair group, assessment was performed at referral, before surgery, and at 6 weeks and 12 months after surgery. For conservatively managed (sometimes referred to as “untreated”) patients, assessment was performed at referral and at 12 months. Often, it was not possible for regional, interstate, and overseas participants to attend all follow-up appointments onsite. Correspondence from local doctors and the family was monitored for changes in functional status, and if sufficient information was available it was incorporated in the patient’s assessment.

Patients were consecutively enrolled in the study regardless of whether their uIA was treated using microsurgical repair or conservative methods. Patients were excluded if their aneurysm was thought to have arisen as a consequence of infection, dissection, or trauma or if it was located outside the subarachnoid space. Patients were excluded if their uIA was treated using an endovascular technique. A flowchart of eligible patients is featured in Fig. 1. Nine patients withdrew participation before or during the preoperative assessments. None of the patients withdrew participation during the follow-up stages as a result of neurological deficits.

**Assessment Tools**

Functional outcome and QOL in the management of uIA were measured with a battery of tests and questionnaires that spanned a large cross section of outcome per-
performances: SF-36 version 2 for the QOL subscales of the Physical Component Summary (PCS) and Mental Component Summary (MCS), modified Barthel Index (mBI) as a measure of self-care performance, modified Rankin Scale (mRS) as a measure of disability for everyday activity, and DS (version 1) component from the DriveSafe DriveAware instrument for neurocognitive evaluation of driving performance.

The DS test and mBI were rated by either the researcher (an occupational therapist) or an assistant researcher (medical practitioner). DriveSafe was administered in a uniform manner, that is, on the same computer in the same consultation room and following the DS protocol, which included the reading of a script before commencing the test. The computer program shows an initial trial scenario and then 11 test scenarios, all of the same intersection with varying combinations of vehicles and pedestrians for 3 seconds (controlled by the program), followed by the question “What did you see?” There are standard instructions and scoring. There was minimal opportunity for misinterpreting the responses; however, in cases in which the verbal response indicated a direction (for example, left) that conflicted with the direction indicated by pointing (for example, right), the pointing direction was accepted as the subject’s response (in DS version 2, pointing is employed).

Before administering the DS test to the enrolled patients with uIAs, a test-retest reliability of DS was performed with 29 healthy volunteers (independent of the enrolled patients with uIAs) who were considered to be capable drivers (that is, had consumed no drugs or alcohol prior to each test that might impair a driver’s performance). The administrator of the test was blinded to the total score from each healthy volunteer until the completion of all tests.

The treating medical management team was blinded to the DS, QOL, and mBI outcomes until analysis of the results in all patients was begun. There was a contingency for a DS score indicative of an unsafe performance (DS score < 96); that is, if such a score were obtained, the score was to be revealed to the surgeon (if the patient had not been advised against driving). Such action was not required during the study period. The mRS scores were allocated by the treating surgeons, and the occupational therapist was blinded to these scores until commencement of the analysis. The PCS and MCS of the SF-36 were extracted by factor analytical techniques. Sequencing of the assessment was planned so that the SF-36 was administered prior to the mBI and DS at each assessment epoch. This order was followed to alleviate the potential impact of a DS score affecting a patient’s perception of their QOL.

### Statistical Analysis

Statistical analysis was performed using IBM SPSS (version 22, IBM Corp.) and Prism (version 7.0, GraphPad Software Inc.). Baseline characteristics were grouped into categorical variables, and we compared surgical and conservative treatment groups using the Pearson chi-square test or Fisher’s exact test for small groups. Continuous variables were analyzed using the t-test, ordinary 1-way ANOVA, or repeated-measures ANOVA. Continuous ordinal regression was used to study the relationships between the predictors and the outcome of interest, the DS score. The latter measures an intangible quantity, the driver’s awareness of the driving environment, and in general cannot be easily modeled because of its inherent nonlinearity. Continuous ordinal regression overcomes this limitation by directly modeling the unobserved quantity of interest, the driver’s awareness of the driving environment, and connecting it to the observed score with a link function that is estimated during the model estimation.

A statistical significance level of 5% was used throughout. Dichotomization of the results, where appropriate, was any score < 100 for the mBI and a score > 1 for the mRS.

### Results

Between January 2011 and January 2016, 209 uIA patients referred to 5 surgeons at Macquarie University were invited to participate in this study. A total of 175 eligible patients gave consent, 169 of whom met the inclusion criteria. Among the patients ineligible for inclusion were 4 who initially had been recommended for and consented to microsurgical repair but subsequently chose endovascular treatment (noted as “treatment plan changed” in Fig. 1).

The test-retest reliability of DS for the healthy volunteers revealed a good intraclass correlation of 0.67 (p < 0.01) with Cronbach’s alpha of 0.8 (Table 1). The paired t-test revealed no significant difference between the 2 tests’ mean scores (initial DS 115 ± 8.9 vs follow-up DS 117 ± 7.9, p = 0.10).

Table 2 shows the baseline characteristics of patients in the conservative treatment and microsurgical repair groups. One-third of the patients were conservatively managed. Of the 112 patients in the microsurgical group, 7 underwent high-flow or internal bypass. There was a significant difference in patient age and size of the uIA between the untreated and microsurgical groups. The mean age was younger (53 vs 58 years, p = 0.01), the mean aneurysm size was larger (6.3 vs 3.6 mm, p < 0.01), and the mean initial DS score was greater (108 vs 104, p < 0.01) for surgical
patients than for untreated patients. However, there was no difference between the 2 groups in the ability to obtain a DS score ≥ 96, which indicates competency to drive.

To detect sample bias between the surgical patients who returned for follow-up assessments and those who did not, the characteristics of the microsurgically managed patients who completed at least 1 set of follow-up assessments (94%) were compared with those in the microsurgically treated patients who did not return for follow-up (6%; Table 2). There were no significance differences between these 2 groups.

Repeated-measures analyses of the subset of patients who completed 3 sets of scores were conducted to examine outcomes according to initial, 6-week postoperative, and 12-month postoperative scores for the surgically treated group. There were no significant changes in the DS, MCS, mBI, and mRS scores in the microsurgical group (Table 3). There was a significant difference in the PCS scores, indicated by a decline in the mean score at 6 weeks after surgery and then a return to the preoperative mean score at 12 months. The analysis was redone using all data from complete and incomplete sets of available scores from each time point and revealed the same results.

In the conservatively managed group, there were no significant changes in the proportional distribution of the mRS and satisfactory mBI scores or in the mean PCS, MCS, and DS scores between the initial and 12-month assessments. For the microsurgical group, there was no significant difference in the mean DS scores among the initial, 6-week, and 12-month scores (108 ± 11, 111 ± 9.7, and 112 ± 10, respectively; p = 0.05).

In a comparison of the surgical and the untreated group, there was no significant difference in the improvement or decline in any of the outcomes at the 12-month assessment (Table 3). A standard deviation of 9 was used to determine a decline in the DS scores. This standard deviation was calculated using the scores obtained from the healthy volunteers sample from the test-retest reliability study (see above). Two (2%) of 100 patients in the surgical group whose initial DS scores had indicated competency to drive subsequently had 12-month postsurgical scores deemed not competent to drive (DS score ≤ 95). In the untreated group, 1 (2%) of 48 patients whose initial DS scores had indicated competency to drive subsequently had 12-month scores deemed not competent to drive (DS score ≤ 95). This difference between the 2 groups was not statistically different (p > 0.99).

Continuous ordinal regression was used to study the relationships between predictors (age, sex, possession of a driver’s license, type of management, time since assessment, mRS score, size of the largest aneurysm, anterior circulation) and the outcome of interest (DS scores). The effect of repeated measures was taken into consideration by incorporating individual random effects in the model. Sex, type of management, and size or location of the uIA, for either the surgical or the untreated group, had no effect

TABLE 2. Characteristics of uIA patients treated conservatively or microsurgically

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conservative Treatment</th>
<th>Microsurgical Repair*</th>
<th>p Value†</th>
<th>No Assessments After Surgery</th>
<th>p Value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of patients (%)</td>
<td>57 (34)</td>
<td>112 (66)</td>
<td>7 (6.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age in yrs</td>
<td>58 ± 15</td>
<td>53 ± 11</td>
<td>&lt;0.01</td>
<td>55 ± 8</td>
<td>0.64</td>
</tr>
<tr>
<td>No. of patients w/ age &lt;60 yrs (%)</td>
<td>28 (49)</td>
<td>77 (69)</td>
<td>&lt;0.01</td>
<td>4</td>
<td>0.68</td>
</tr>
<tr>
<td>No. of females (%)</td>
<td>36 (63)</td>
<td>83 (74)</td>
<td>0.14</td>
<td>3</td>
<td>0.07</td>
</tr>
<tr>
<td>No. of patients w/ largest uIA in pst location (%)</td>
<td>7 (12)</td>
<td>4 (3.6)</td>
<td>0.05</td>
<td>1</td>
<td>0.23</td>
</tr>
<tr>
<td>No. of patients w/ multiple uAs (%)</td>
<td>9 (16)</td>
<td>30 (27)</td>
<td>0.13</td>
<td>2</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Mean uIA size in mm</td>
<td>3.6 ± 1.7</td>
<td>6.3 ± 4.7</td>
<td>&lt;0.01</td>
<td>7 ± 4</td>
<td>0.72</td>
</tr>
<tr>
<td>No. of uAs &gt;10 mm (%)</td>
<td>0 (0)</td>
<td>11 (9.8)</td>
<td>0.02</td>
<td>1</td>
<td>0.53</td>
</tr>
<tr>
<td>No. of microsurgical repairs by direct clipping</td>
<td>NA</td>
<td>105</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of microsurgical repairs including bypass</td>
<td>NA</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean initial DS score</td>
<td>104 ± 16</td>
<td>108 ± 11</td>
<td>&lt;0.01</td>
<td>113 ± 4</td>
<td>0.27</td>
</tr>
<tr>
<td>No. of patients w/ initial DS score ≤95 (%)</td>
<td>9 (16)</td>
<td>12 (11)</td>
<td>0.34</td>
<td>0</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Mean initial PCS (no. of patients w/ data)</td>
<td>50 ± 5 (52)</td>
<td>52 ± 8 (109)</td>
<td>0.16</td>
<td>50 ± 9 (7)</td>
<td>0.59</td>
</tr>
<tr>
<td>No. of patients w/ initial PCS &lt;50 (%)</td>
<td>24 (46)</td>
<td>44 (40)</td>
<td>0.49</td>
<td>2 (29)</td>
<td>0.70</td>
</tr>
<tr>
<td>Mean initial MCS (no. of patients w/ data)</td>
<td>48 ± 12 (52)</td>
<td>47 ± 11 (109)</td>
<td>0.69</td>
<td>47 ± 13 (7)</td>
<td>0.97</td>
</tr>
<tr>
<td>No. of patients w/ initial MCS &lt;50 (%)</td>
<td>22 (42)</td>
<td>53 (49)</td>
<td>0.49</td>
<td>3 (43)</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>No. of patients w/ initial mRS score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2</td>
<td>55 (96)</td>
<td>110 (98)</td>
<td>&gt;0.99</td>
<td>7 (100)</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>2</td>
<td>2 (3.5)</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>&gt;2</td>
<td>0</td>
<td>2 (1.8)</td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

pst = posterior.

Values expressed as mean ± standard deviation unless indicated otherwise.

* Patients both followed and not followed.
† Comparing surgical with conservative treatment cases (chi-square, Fisher’s exact, or t-test).
‡ Comparing group with no follow-up after surgery and group with follow-up after surgery (chi-square, Fisher’s exact, or t-test).
on the DS scores. A younger age (p < 0.01), possession of a driver’s license (p < 0.01), and an mRS score of 0 at each assessment (p < 0.01) were related to higher DS scores (Table 4). Models in which the effect of time since the first assessment was modeled nonlinearly proved to be a better fit for the data. Patients showed an improvement in DS scores over time, with a peak at about 600 days after the first assessment (Fig. 2 upper). This effect was more evident in the surgical group, but the differences between the surgical and conservative groups were not significant (Fig. 2 lower).

Discussion

In this study of 169 patients with uIAs, patient function and QOL were maintained or regained 12 months after either conservative or microsurgical management. There was no significant difference between the untreated and surgically managed groups in terms of the PCS, MCS, mRS, or DS scores 12 months after initial presentation, nor was there a significant change within each group for each follow-up (initial presentation, 6 weeks [surgical group only], and 12 months) with the exception of a transient decline in PCS after surgery at 6 weeks that recovered to the initial mean score at 12 months. Microsurgical repair was performed via aneurysm clipping in 94% of cases, and a more complex repair that included the addition of bypass (including high-flow and internal bypass) was necessary in 6%. The indications for bypass were larger, more complex aneurysms. Although a more complex microsurgical procedure, bypass could not always be anticipated prior to surgery; therefore, patients treated with bypass should not, and were not, excluded from analysis. Other microsurgical repair variations included the use of temporary clips. Note that the senior author’s practice has examined the role of temporary clipping, employed in 35% of more than 1000 cases of uIA, and its use was highly correlated with aneurysm size. Therefore, given the correlation between temporary clipping and uIA complexity, it is extremely difficult to explore the independent impact of temporary clipping in this cohort.

Microsurgical repair patients experienced a significant decline in their PCS score in the first 6 weeks after surgery, but the score recovered by 12 months. This finding differed from previous reports of a long-term decline in QOL. This difference may be explained by the duration of follow-up from which the QOL data were taken or an undefined difference in the population in which other studies were performed.

With regard to DS, there was a relationship between age, sex, or possession of a driver’s license and driving performance at 12 months. Younger patients, female patients, and patients with a driver’s license had significantly higher DS scores. The correlation between possession of a driver’s license and a higher DS score is expected since the DS test screens a person’s awareness of the driving environment. There was no relationship between the size or location of the uIA and the DS score for either conservatively or surgically managed uIAs. There was no correlation between the QOL measures and the DS scores. This result implies that to ensure all surgical outcomes
are measured, a battery of tests assessing function, QOL, and neurological deficits is needed. The trend of improvement in the DS score after surgery, although not statistically significant, raises the question of whether bias was a factor in the study. We considered a number of possibilities to explain this trend, including a learning bias and a bias arising from anxiety impairing the first test performance. The absence of a similar pattern in the untreated UIAs and the test-retest reliability in the healthy controls suggest that a learning bias can be reasonably excluded. The reason for the lower initial score for those undergoing microsurgical repair was most likely attributable to anxiety about the pending surgery, which was often scheduled within a few days of referral to the neurosurgical team. We believe that the examinees would have endeavored to do their best since an unsatisfactory performance at any assessment might have precluded them from driving. Furthermore, an improving performance for those who were already performing at a level above the minimum standard to permit driving was of no benefit with respect to driving. Seven percent of patients in the microsurgical group and 5% in the untreated group were initially below the level considered safe to drive (all in nondrivers). There was no statistically significant difference between these 2 groups. The mean DS score was marginally higher in the microsurgical group than in the untreated group. We believe that the patients in either cohort, whether treated or untreated, were highly motivated to perform well to ensure that they could resume driving.

Study Limitations

The limitations of cohort studies are well known. There is the problem of whether the treated cohort reflects the general population with UIAs. In our study, patients were likely to present with more surgically complex aneurysms, reflecting a referral bias to a center with expertise in cerebrovascular surgery. To reduce potential bias, all patients with newly diagnosed UIAs who were referred to the neurosurgery team at Macquarie University were asked to enroll in this study. Patients referred for endovascular treatment were not included in the study. Of the 209 patients referred to the neurosurgical team during the study period, very few were subsequently referred for endovascular treatment (“treatment plan changed”). It is not possible to know how many patients were referred for endovascular treatment and did not present to the neurosurgical team. This pragmatic study, performed in patients after a management decision was reached, is therefore biased toward those patients who the treating surgeons believed would be better served through microsurgical repair than endovascular repair. This acknowledges the present diversity of management pathways, which has been discussed in a publication by the senior author (M.K.M.).13 Although microsurgical treatment usually consisted of clipping alone, this was not the case in 6% of cases in which more complex repair via high-flow bypass or internal bypass was necessary. However, it was considered appropriate to combine the more complex repair with simple clipping in these complex cases since it is not always possible to anticipate the use of the more complex repairs before surgery. A further limitation is that the mRS grading of outcomes is not independent of the treating surgeon. However, the DS, mBI, and QOL outcomes were independent of the neurosurgeon, and blinding of the administrator of the DS and QOL measures to the mRS score was an attempt to minimize the surgeon’s bias regarding outcome. Furthermore, dichotomizing outcomes as mRS score 1 versus 2 is likely to improve the reliability of the use of the mRS in this study as this point of dichotomization has been reported to have greater reliability than between other points on the mRS.27

The patients were highly motivated to perform well on the DS test to ensure that they could return to driving. This cannot always be said of the QOL tests for which a poor performance has few negative consequences for the patient. The method of administering the DS test on a computer screen, the independence of its administrators, and the test’s high interrater reliability as reported by Kay and colleagues suggest that the potential bias of the neurosurgical team in wishing for favorable outcomes was minimized.10 Furthermore, the researchers are aware of the responsibility involved in a recommendation for a return to driving for both the patient and the community. It is necessary for others to corroborate our findings to be sure that an early return to driving is appropriate.

The participation and compliance rate in this study was relatively high at 94%, as compared with rates from similar studies comparing presurgical function with postsurgical outcomes.3,12,18,22 The 112 surgical and 57 no-treatment patients had either complete or partial follow-up data as appropriate for analysis, with only 7 noncompliant patients having to be excluded.

Driving is an everyday task for most adults in the developed world. The DS test was administered at each follow-up consultation, enabling the treating surgeon to decide when it was safe for a patient to return to driving. Surgeons were not informed of patients’ actual scores, but they were able to make recommendations on patients’ fitness to return to driving following surgery. Patients may have been influenced to participate in postoperative follow-up assessments because completion of the DS test would provide reassurance about their cognitive ability to drive.

The 3 major medical reasons for withholding permission to return to driving following UIA surgery are a dis-
ability that prevents driving (for example, visual field deficit), seizures, and cognitive impairment. We have reported our results for seizures following the surgical management of uIA. The risk of a first postoperative seizure following discharge from the hospital in patients who had no preoperative seizures, no middle cerebral artery aneurysms, and no postoperative complications (leading to an mRS score > 1) was < 0.1% and 1.1% at 12 months and 7 years, respectively. The results in our present study showed that there is an overall maintenance of cognitive function in relation to driving after surgery for uIA.

**Conclusions**

There is no loss in QOL, as measured by PCS or MCS scores, following surgery as compared with conservative management of uIAs. Microsurgical management of a uIA did not affect cognitive abilities relevant to a return to

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**FIG. 2.** Continuous ordinal regression analysis results. The DS score against time demonstrated improvement in scores after surgery (upper) for uIAs (estimate and 95% confidence of estimate). The more negative the value on the y-axis, the greater the improvement. Beyond 600 days, the number of assessments was few and the data were less reliable. Comparing the surgical group (broken line, lower) with the conservative group (solid line) demonstrates no overall difference in DS scores. DSDA = DriveSafe DriveAware.
driving at 6 weeks or 12 months after surgery. Guidelines that restrict driving for periods longer than 6 weeks after surgery for uA on the basis of concerns for potential cognitive dysfunction should be reconsidered.

References

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Author Contributions
Conception and design: Morgan, O’Donnell. Acquisition of data: Morgan, O’Donnell. Analysis and interpretation of data: Morgan, O’Donnell. Drafting the article: Morgan, O’Donnell. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Morgan. Statistical analysis: all authors. Administrative/technical/material support: Morgan. Study supervision: Morgan.

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